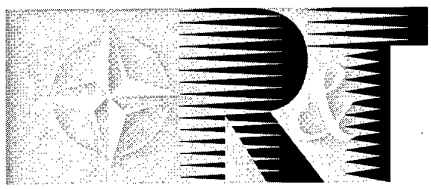
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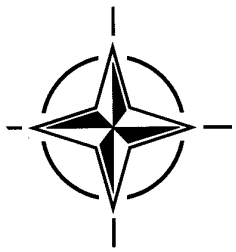
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AGARD
Index of Publications
1995-1998
(Index des publications 1995-1998)

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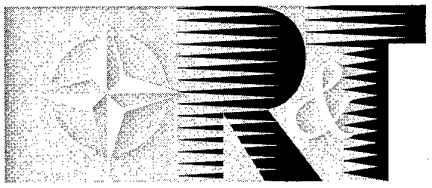
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The Research and Technology Organization (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote cooperative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective coordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also coordinates RTO's cooperation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of initial cooperation.

The total spectrum of R&T activities is covered by 7 Panels, dealing with:

- SAS Studies, Analysis and Simulation
- SCI Systems Concepts and Integration
- SET Sensors and Electronics Technology
- IST Information Systems Technology
- AVT Applied Vehicle Technology
- HFM Human Factors and Medicine
- MSG Modelling and Simulation

These Panels are made up of national representatives as well as generally recognised 'world class' scientists. The Panels also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier cooperation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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Preface

This volume provides abstracts and indexes for AGARD* unclassified publications during the period 1995-1998. By an arrangement with U.S. National aeronautics and Space administration (CASA) in Washington, DC, the computerized NASA STI Database has been used to prepare this publication.

Full bibliographic citations and abstracts for all the documents in this publication are given in the Abstract Section, which is organized in the major subject divisions and specific categories used by NASA in abstract journals and bibliographies. The subject divisions and categories are given in the Subject Categories list, together with a note for each that defines its scope and provides any cross-references. Within each category, the abstracts are arranged by document ID number.

Six indexes – Subject (based on NASA Thesaurus nomenclature), Personal Author, Panel, Report Number, ISBN and Document ID Number – are included.

Details of AGARD's classified publications for the same period are contained in a companion, classified, index.

This volume completes the series of paper indexes of AGARD publications for 1952-1998.

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* AGARD and the Defense Research Group of NATO (DRG) merged on 1 January 1998 to form the Research and Technology Organization (RTO) of NATO. However, both AGARD and DRG continued to issue publications under their own names in 1998 in respect of work performed in 1997.

Préface

Ce volume contient des résumés et des indexes relatifs aux publications non-classifiées de l'AGARD parues entre 1995 et 1998. Selon l'accord qui existe entre l'AGARD et l'US National Aeronautics and Space Administration (NASA) à Washington DC, la base de données informatisée STI de la NASA a été utilisée pour la préparation de la présente publication.

Des résumés et des citations détaillés relatifs à tous les documents figurant dans cette publications sont inclus dans la section résumés de l'ouvrage, qui est organisée selon les domaines principaux et les catégories spécifiques employés par la NASA dans ses recueils de résumés et ses bibliographies. Les domaines et les catégories sont énumérés en anglais dans la liste en page v, avec une note pour chacun d'entre eux définissant son contenu et indiquant d'éventuels renvois. Les résumés sont classés par numéro d'identification à l'intérieur de chaque catégorie.

Six indexes en tout sont presentés, à savoir, Matière (selon la nomenclature du Thesaurus de la NASA), Auteur individuel, Panel, Numéro de rapport, ISBN et Numéro d'identification.

Le détail des publications classifiées de l'AGARD pour le même période est donné dans un autre index, classifié, dans la même série.

Ce volume complète les séries des papiers indexés des publications de l'AGARD pour la periode de 1952 à 1998.

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* L'AGARD a fusionné avec le Groupe sur la recherche pour la défense (GRD) le premier janvier 1998, pour former l'Organisation pour la recherche et la technologie de l'OTAN (RTO). Cependant, l'AGARD et le GRD ont continué d'éditer en 1998, sous leur propre noms, des publications relatives à leurs activités de 1997.

Subject Categories

AERONAUTICS For related information see also *Astronautics.*

01 **AERONAUTICS (GENERAL)** 1

02 **AERODYNAMICS** 7
Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery. For related information, see also *34 Fluid Mechanics and Heat Transfer.*

03 **AIR TRANSPORTATION AND SAFETY** 26
Includes passenger and cargo air transport operations; and aircraft accidents. For related information, see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

04 **AIRCRAFT COMMUNICATIONS AND NAVIGATION** 37
Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control. For related information, see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *32 Communications Radar.*

05 **AIRCRAFT DESIGN, TESTING AND PERFORMANCE** 53
Includes aircraft simulation technology. For related information, see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics.* For land transportation vehicles, see *85 Urban Technology and Transportation.*

06 **AIRCRAFT INSTRUMENTATION** 96
Includes cockpit and cabin display devices; and flight instruments. For related information, see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

07 **AIRCRAFT PROPULSION AND POWER** 103
Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft. For related information, see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

08 **AIRCRAFT STABILITY AND CONTROL** 120
Includes aircraft handling qualities; piloting; flight controls; and autopilots. For related information, see also *05 Aircraft Design, Testing and Performance.*

09 **RESEARCH AND SUPPORT FACILITIES (AIR)** 129
Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands. For related information, see also *14 Ground Support Systems and Facilities (Space).*

ASTRONAUTICS For related information see also *Aeronautics.*

12 **ASTRONAUTICS (GENERAL)** 145
For extraterrestrial exploration, see *91 Lunar and Planetary Exploration.*

13 **ASTRODYNAMICS** N.A.
Includes powered and free-flight trajectories; and orbital and launching dynamics.

14 **GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)** 146
Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators. *For related information, see also 09 Research and Support Facilities (Air).*

15 **LAUNCH VEHICLES AND SPACE VEHICLES** 146
Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles. For related information, see also *20 Spacecraft Propulsion and Power.*

16 **SPACE TRANSPORTATION** 147
Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques. For related information, see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits, see *54 Man/System Technology and Life Support.*

17 **SPACE COMMUNICATIONS, SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING** 148
Includes telemetry; space communication networks; astronavigation and guidance; and radio blackout. For related information, see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

18 **SPACECRAFT DESIGN, TESTING AND PERFORMANCE** 148
Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls. For life support systems, see *54 Man/System Technology and Life Support.* For related information, see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics, and 16 Space Transportation.*

N.A. — No abstracts were assigned to this category for this issue.

19 SPACECRAFT INSTRUMENTATION 153
For related information, see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

20 SPACECRAFT PROPULSION AND POWER 153
Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources. For related information, see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

CHEMISTRY AND MATERIALS

23 CHEMISTRY AND MATERIALS (GENERAL) 154

24 COMPOSITE MATERIALS 155
Includes physical, chemical, and mechanical properties of laminates and other composite materials. For ceramic materials see *27 Nonmetallic Materials.*

25 INORGANIC AND PHYSICAL CHEMISTRY 160
Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry. For related information see also *77 Thermodynamics and Statistical Physics.*

26 METALLIC MATERIALS 162
Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

27 NONMETALLIC MATERIALS 166
Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials. For composite materials see *24 Composite Materials.*

28 PROPELLANTS AND FUELS 172
Includes rocket propellants, igniters and oxidizers; their storage and handling procedures; and aircraft fuels. For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

29 MATERIALS PROCESSING N.A.
Includes space-based development of products and processes for commercial application. For biological materials see *55 Space Biology.*

ENGINEERING

31 ENGINEERING (GENERAL) 186
Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

32 COMMUNICATIONS AND RADAR 193
Includes radar; land and global communications; communications theory; and optical communications. For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see 03 Air Transportation and Safety, and *16 Space Transportation.*

33 ELECTRONICS AND ELECTRICAL ENGINEERING 237
Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry. For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

34 FLUID MECHANICS AND HEAT TRANSFER 239
Includes boundary layers; hydrodynamics; fluidics; mass transfer and ablation cooling. For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

35 INSTRUMENTATION AND PHOTOGRAPHY 263
Includes remote sensors; measuring instruments and gauges; detectors; cameras and photographic supplies; and holography. For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation* and *19 Spacecraft Instrumentation.*

36 LASERS AND MASERS 267
Includes parametric amplifiers. For related information see also *76 Solid-State Physics.*

37 MECHANICAL ENGINEERING 269
Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

38 QUALITY ASSURANCE AND RELIABILITY 273
Includes product sampling procedures and techniques; and quality control.

39 STRUCTURAL MECHANICS 275
Includes structural element design and weight analysis; fatigue; and thermal stress. For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

N.A. — No abstracts were assigned to this category for this issue.

GEOSCIENCES

42 GEOSCIENCES (GENERAL) N.A.

43 EARTH RESOURCES AND REMOTE SENSING 280
Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography. For instrumentation see *35 Instrumentation and Photography.*

44 ENERGY PRODUCTION AND CONVERSION N.A.
Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower. For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

45 ENVIRONMENT POLLUTION 288
Includes atmospheric, noise, thermal, and water pollution.

46 GEOPHYSICS 291
Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism. For space radiation see *93 Space Radiation.*

47 METEOROLOGY AND CLIMATOLOGY 293
Includes weather forecasting and modification.

48 OCEANOGRAPHY 294
Includes biological, dynamic, and physical oceanography; and marine resources. For related information see also *43 Earth Resources and Remote Sensing.*

LIFE SCIENCES

51 LIFE SCIENCES (GENERAL) N.A.

52 AEROSPACE MEDICINE 295
Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

53 BEHAVIORAL SCIENCES 316
Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT 332
Includes human engineering; biotechnology; and space suits and protective clothing. For related information see also *16 Space Transportation.*

55 SPACE BIOLOGY N.A.
Includes exobiology; planetary biology; and extraterrestrial life.

MATHEMATICAL AND COMPUTER SCIENCES

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL) N.A.

60 COMPUTER OPERATIONS AND HARDWARE 343
Includes hardware for computer graphics, firmware, and data processing. For components see *33 Electronics and Electrical Engineering.*

61 COMPUTER PROGRAMMING AND SOFTWARE 344
Includes computer programs, routines, algorithms, and specific applications, e.g., CAD/CAM.

62 COMPUTER SYSTEMS 350
Includes computer networks and special application computer systems.

63 CYBERNETICS 352
Includes feedback and control theory, artificial intelligence, robotics and expert systems. For related information see also *54 Man/System Technology and Life Support.*

64 NUMERICAL ANALYSIS 355
Includes iteration, difference equations, and numerical approximation.

65 STATISTICS AND PROBABILITY N.A.
Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

66 SYSTEMS ANALYSIS 356
Includes mathematical modeling; network analysis; and operations research.

67 THEORETICAL MATHEMATICS 370
Includes topology and number theory.

N.A. — No abstracts were assigned to this category for this issue.

PHYSICS

70 **PHYSICS (GENERAL)** **N.A.**
For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

71 **ACOUSTICS** **370**
Includes sound generation, transmission, and attenuation. For noise pollution see *45 Environment Pollution.*

72 **ATOMIC AND MOLECULAR PHYSICS** **N.A.**
Includes atomic structure, electron properties, and molecular spectra.

73 **NUCLEAR AND HIGH-ENERGY PHYSICS** **N.A.**
Includes elementary and nuclear particles; and reactor theory. For space radiation see *93 Space Radiation.*

74 **OPTICS** **372**
Includes light phenomena and optical devices. For lasers see *36 Lasers and Masers.*

75 **PLASMA PHYSICS** **N.A.**
Includes magnetohydrodynamics and plasma fusion. For ionospheric plasmas see *46 Geophysics.* For space plasmas see *90 Astrophysics.*

76 **SOLID-STATE PHYSICS** **N.A.**
Includes superconductivity. For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

77 **THERMODYNAMICS AND STATISTICAL PHYSICS** **376**
Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics. For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

SOCIAL SCIENCES

80 **SOCIAL SCIENCES (GENERAL)** **N.A.**
Includes educational matters.

81 **ADMINISTRATION AND MANAGEMENT** **377**
Includes management planning and research.

82 **DOCUMENTATION AND INFORMATION SCIENCE** **382**
Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography. For computer documentation see *61 Computer Programming and Software.*

83 **ECONOMICS AND COST ANALYSIS** **N.A.**
Includes cost effectiveness studies.

84 **LAW, POLITICAL SCIENCE AND SPACE POLICY** **387**
Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

85 **URBAN TECHNOLOGY AND TRANSPORTATION** **387**
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation. For related information see *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

SPACE SCIENCES

88 **SPACE SCIENCES (GENERAL)** **N.A.**

89 **ASTRONOMY** **N.A.**
Includes radio, gamma-ray, and infrared astronomy; and astrometry.

90 **ASTROPHYSICS** **N.A.**
Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust. For related information see also *75 Plasma Physics.*

91 **LUNAR AND PLANETARY EXPLORATION** **387**
Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

92 **SOLAR PHYSICS** **N.A.**
Includes solar activity, solar flares, solar radiation and sunspots. For related information see also *93 Space Radiation.*

N.A. — No abstracts were assigned to this category for this issue.

93 SPACE RADIATION N.A.
Includes cosmic radiation; and inner and outer earth's radiation belts. For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

GENERAL

99 GENERAL 387
Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

N.A. — No abstracts were assigned to this category for this issue.

Typical Report Citation and Abstract

❶ **19950017086** AVRO International Aerospace, Engineering Test Facilities, Woodford, UK
❷ **HEALTH AND USAGE MONITORING SYSTEMS: CORROSION SURVEILLANCE**
❸ Smart, J. D., AVRO International Aerospace, UK; Weetman, D. C., Real Time Corrosion Management Ltd., UK; AGARD, Corrosion
❹ Detection and Management of Advanced Airframe Materials; Jan 1,
❺ 1995; 11 p; In English; See also 19950017076; Copyright; Avail: CASI;
❻ A03, Hardcopy; A03, Microfiche
❼ A predictive method of determining the inspection requirements for specific areas of individual aircraft could offer major advantages in terms of safety and maintenance and repair costs. An approach such as Health and Usage Monitoring in Service, in which the condition of components is monitored whilst in operation, would allow inspection requirements to be minimized and maintenance to be carried out as it becomes necessary. to use such an approach on aircraft would require very sensitive monitoring techniques. Modern electrochemical corrosion instrumentation could offer the required levels of sensitivity for detecting and characterizing the corrosion processes which precede the development of observable damage. This paper details a program carried out to assess the suitability of such electrochemical monitoring instrumentation for aerospace applications and to assess the feasibility of producing an aircraft system on which a predictive corrosion monitoring system could be based.
❽ Author
❾ *Aircraft Structures; Corrosion; Detection; Electrochemistry; Inspection*

Key

1. Document ID Number; Corporate Source and Location
2. Title
3. Author(s) and Affiliation(s)
4. Conference/Publication Information; Publication Date
5. Other Pub. Info.; Parent/Subsidiary Doc. ID Number(s)*; Availability
6. Price Codes
7. Abstract
8. Abstract Author
9. Subject Terms

* See the Document ID Index for the location(s) of this/these publication(s).

AGARD INDEX OF PUBLICATIONS (1995–1998)

ABSTRACT SECTION

01
AERONAUTICS (GENERAL)

19950017086 AVRO International Aerospace, Engineering Test Facilities., Woodford, United Kingdom
HEALTH AND USAGE MONITORING SYSTEMS: CORROSION SURVEILLANCE
Smart, J. D., AVRO International Aerospace, UK; Weetman, D. C., Real Time Corrosion Management Ltd., UK; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 11 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

A predictive method of determining the inspection requirements for specific areas of individual aircraft could offer major advantages in terms of safety and maintenance and repair costs. An approach such as Health and Usage Monitoring in Service, in which the condition of components is monitored whilst in operation, would allow inspection requirements to be minimized and maintenance to be carried out as it becomes necessary. to use such an approach on aircraft would require very sensitive monitoring techniques. Modern electrochemical corrosion instrumentation could offer the required levels of sensitivity for detecting and characterizing the corrosion processes which precede the development of observable damage. This paper details a program carried out to assess the suitability of such electrochemical monitoring instrumentation for aerospace applications and to assess the feasibility of producing an aircraft system on which a predictive corrosion monitoring system could be based.
Author
Aircraft Structures; Corrosion; Detection; Electrochemistry; Inspection

19950017099 Department of the Air Force, Tinker AFB, OK, United States
OKLAHOMA CITY AIR LOGISTICS CENTER (USAF) AGING AIRCRAFT CORROSION PROGRAM
Nieser, Donald E., Department of the Air Force, USA; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 12 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Because of projected reductions in future defense budgets, less money will be available for new aircraft acquisitions. Consequently, many of the current aircraft will have to be maintained well into the twenty-first century. As they continue to age, the time-dependent effects of material degradation, due to corrosion, will become more significant. Having to maintain aircraft three to four times their original design life presents a unique new set of complex technical problems and challenges. The primary concern is the reduction of airframe fatigue life and static strength due to widespread corrosion damage, fatigue, embrittlement, material loss due to corrosion, intergranular corrosion attack, fretting and stress concentrations. In an effort to ensure continued airworthiness and flight safety, an aggressive program plan has been developed and implemented at Tinker AFB to try to solve the corrosion problems and fatigue related problems to present the occurrence of catastrophic structural failures. The program consists of (1) invasive disassembly of a complete C/KC-135 and sections of B-52 and Boeing 707 aircraft, (2) corrosion documentation/information system development, (3) analysis and testing the effects of corrosion on structural integrity, as well as corrosion growth rates, (4) corrosion modeling and development of C/KC-135 service life extension strategies, (5) and comprehensive evaluation of nondestructive inspection/testing (NDI/NDT) equipment for hidden corrosion detection and quantification. This program has been extensively coordinated with USAF Wright Labs, AFOSR, Naval Air Warfare Center, FAA Aging Aircraft Center, NASA Langley, industry and academia.
Author
Aging (Materials); Aircraft Reliability; Aircraft Structures; Airframes; Corrosion; Degradation; Flight Safety; Service Life

19960003572 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
AERODYNAMICS AND AEROACOUSTICS OF ROTORCRAFT ***L'AERODYNAMIQUE ET L'AEROACOUSTIQUE DES AERONEFS A VOILURE TOURNANTE***
Aug 1, 1995; 489p; In English; In French; 75th, 10-13 Oct. 1994, Berlin, Germany; See also 19960003573 through 19960003607
Report No.(s): AGARD-CP-552; ISBN 92-836-0015-0; Copyright Waived; Avail: CASI; A21, Hardcopy; A04, Microfiche; Original contains color illustrations

The papers prepared for the AGARD Fluid Dynamics Panel (FDP) Symposium on 'Aerodynamics and Aeroacoustics of Rotorcraft', which was held 10-13 October 1994 in Berlin, Germany are contained in this Report. In addition, a Technical Evaluator's Report aimed at assessing the success of the Symposium in meeting its objectives, and an edited transcript of the General Discussion held at the end of the Symposium are also included. The Symposium brought together scientists in different fields of aerodynamics and aeroacoustics to review and discuss their recent results in the area of rotary-wing aircraft in order to foster future development. The program included 35 papers from North American, Western Europe, and Russian organized in the following technical sessions: Dynamics Stall, Wind Turbines, Aerodynamic 3D Prediction Methods, Experimental Investigations of Helicopter Rotors, Acoustic Predictions Methods, and Interference Problems.
Aeroacoustics; Aerodynamic Stalling; Blade-Vortex Interaction; Computational Fluid Dynamics; Conferences; Helicopters; Hovering; Navier-Stokes Equation; Noise Prediction (Aircraft); Rotary Wings; Rotor Aerodynamics; Rotor Blades; Wind Turbines

19960003573 United Technologies Research Center, East Hartford, CT, United States
NEW DIRECTIONS IN ROTORCRAFT COMPUTATIONAL AERODYNAMICS RESEARCH IN THE US
Landgrebe, Anton J., United Technologies Research Center, USA; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 12 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche; Original contains color illustrations

Recent research activities in the USA are presented that are representative of the directions of research for computational aerodynamics for rotorcraft. Emphasis is given to Navier-Stokes methodology for airflow and airload prediction, and specifically the fundamental technical challenges associated with grid systems and achieving wake generation without numerical diffusion. Although the current rotorcraft CFD methods have not yet generally demonstrated sufficient accuracy for the helicopter industry, the recent rate of progress is encouraging.
Author
Aerodynamic Loads; Aircraft Design; Computational Fluid Dynamics; Grid Generation (Mathematics); Helicopters; Navier-Stokes Equation; Research; Rotor Aerodynamics; Structured Grids (Mathematics); Unstructured Grids (Mathematics)

19960003590 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik., Brunswick, Germany
ROTORCRAFT SYSTEM IDENTIFICATION: AN OVERVIEW OF AGARD FVP WORKING GROUP 18
Hamel, Peter G., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Kaletka, Juergen, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 16 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The AGARD FVP Panel, which for the last 20 years has sponsored activities in the field of flight vehicle system identification, decided in 1987 to set up the FVP Working Group 18, tasked with exploring and reporting on the topic of rotorcraft System Identification. Using flight test data bases from three different helicopters, specialists from research organizations and industry applied their individual eval-

uation techniques for data quality checking and for the identification and verification of flight-mechanical models. The accomplishments of the Working Group are documented in the Final Report. This paper gives a broad overview on the basic identification methodology and the practical approaches. Representative results are given to illustrate the main identification steps: specific flight test maneuvers and required measurements, definition of appropriate model structures, application of identification methods, and verification of the results. The Working Group mainly concentrated on the determination of 6 DOF rigid body models. Based on the experience gained in the Group, higher order models have recently been identified. Therefore, the paper also addresses the advances and gives an example for the application of the obtained models.
Author
Data Reduction; Dynamic Response; Flight Simulation; Flight Tests; Mathematical Models; Maximum Likelihood Estimates; Rotary Wing Aircraft; System Identification

19960003591 NASA Ames Research Center, Moffett Field, CA, United States
EFFECT OF INDIVIDUAL BLADE CONTROL ON NOISE RADIATION
Swanson, S. M., NASA Ames Research Center, USA; Jacklin, Stephen A., NASA Ames Research Center, USA; Niesl, G., Eurocopter Deutschland G.m.b.H., Germany; Blaas, Achim, Zahnradfabrik Friedrichshafen A.G., Germany; Kube, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 12 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

In a joint research program of NASA Ames Research Center, ZF Luftfahrttechnik, the German Aerospace Research Establishment (DLR), and EUROCOPTER Deutschland, a wind tunnel test was performed to evaluate the effects of Individual Blade Control (IBC) on rotor noise. This test was conducted in the 40x80 ft wind tunnel at NASA Ames Research Center, utilizing a full scale MBB-BO 105 four-bladed rotor system. Three microphones were installed for determination of the radiated noise, two of them on a moveable traverse below the advancing blade side and one in a fixed location below the retreating side. Acoustic results are presented for flight conditions with Blade-Vortex-Interaction (BVI) noise radiation. High noise level reductions were measured for single harmonic control inputs. In addition to the single harmonic inputs, multi-harmonic inputs were evaluated by superimposing 2/rev to 6/rev harmonics. For the first time the efficiency of sharp wavelets (60 deg and 90 deg width) on acoustic noise were measured. In order to achieve an adequate wavelet shape at the blade tip, corrections were made to account for the blade torsional behavior. In parallel with the acoustic measurements, vibratory loads were measured during the BVI flight condition to correlate the effects of IBC on noise and vibrations. It is shown how noise levels and vibrations are affected by specific IBC control inputs. In addition, correlations are made between noise levels and acoustic time histories with IBC phase and amplitude variations. For one IBC input mode with high noise reducing efficiency, a sweep of the moveable microphone traverse below the advancing side shows the effect on BVI noise directivity.
Author
Aeroacoustics; Aerodynamic Noise; Blade-Vortex Interaction; BO-105 Helicopter; Harmonic Control; Noise Intensity; Noise Measurement; Noise Reduction; Rotary Wings; Rotor Aerodynamics; Vibratory Loads; Wind Tunnel Tests

19960003592 NASA Ames Research Center, Moffett Field, CA, United States
A STUDY OF BLADE-VORTEX INTERACTION AEROACOUSTICS UTILIZING AN INDEPENDENTLY GENERATED VORTEX
Kitaplioglu, C., NASA Ames Research Center, USA; Caradonna, F. X., Army Aviation Systems Command, USA; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 19 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents results from an experimental study of rotor blade-vortex interaction (BVI) aerodynamics and acoustics. The experiment utilized an externally generated vortex interacting with a two-bladed rotor operating at zero thrust to minimize the influence of the rotor's own wake. The rotor blades were instrumented with a total of 60 absolute pressure transducers at three spanwise and ten chordwise stations on both the upper and lower surfaces. Acoustic data were obtained with fixed near-field microphones as well as a movable array of far-field microphones. The test was carried out in the acoustically treated test section of the NASA Ames 80- by 120-foot Wind Tunnel. Several parameters which influences BVI, such as vortex-rotor separation distance, vortex strength, and vortex sense (swirl direction), as well as rotor tip Mach number and advance ratio, were varied. Simultaneous measurements were obtained of blade surface pressure distributions, near-field acoustics, and far-field acoustics during the vortex-blade encounters.
Author
Aeroacoustics; Aerodynamic Noise; Blade-Vortex Interaction; Far Fields; Helicopters; Near Fields; Noise Measurement; Pressure Distribution; Pressure Measurement; Rotor Aerodynamics; Surface Noise Interactions; Vortices; Wind Tunnel Tests

19960003598 NASA Langley Research Center, Hampton, VA, United States
EFFECT OF HIGHER HARMONIC CONTROL ON HELICOPTER ROTOR BLADE-VORTEX INTERACTION NOISE: PREDICTION AND INITIAL VALIDATION
Beaumier, P., Office National d'Etudes et de Recherches Aerospatiales, France; Prieur, J., Office National d'Etudes et de Recherches Aerospatiales, France; Rahier, G., Office National d'Etudes et de Recherches Aerospatiales, France; Spiegel, P., Office National d'Etudes et de Recherches Aerospatiales, France; Demargne, A., Office National d'Etudes et de Recherches Aerospatiales, France; Tung, C., Army Aviation Systems Command, USA; Gallman, J. M., Army Aviation Systems Command, USA; Yu, Y. H., Army Aviation Systems Command, USA; Kube, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Vanderwall, B. G., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 21 p; In English; See also 19960003572; Prepared in cooperation with Lockheed Engineering and Sciences Co., Hampton, VA; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The paper presents a status of theoretical tools of AFDD, DLR, NASA and ONERA for prediction of the effect of HHC on helicopter main rotor BVI noise. Aeroacoustic predictions from the four research centers, concerning a wind tunnel simulation of a typical descent flight case without and with HHC are presented and compared. The results include blade deformation, geometry of interacting vortices, sectional loads and noise. Acoustic predictions are compared to experimental data. An analysis of the results provides a first insight of the mechanisms by which HHC may affect BVI noise.
Author
Aeroacoustics; Aerodynamic Noise; Blade-Vortex Interaction; Harmonic Control; Helicopters; Noise Measurement; Noise Prediction; Noise Reduction; Prediction Analysis Techniques; Rotary Wings; Rotor Aerodynamics; Wind Tunnel Tests

19960003605 Maryland Univ., Dept. of Aerospace Engineering., College Park, MD, United States
THE ROLE AND STATUS OF EULER SOLVERS IN IMPULSIVE ROTOR NOISE COMPUTATIONS
Baeder, James D., Maryland Univ., USA; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 16 p; In English; See also 19960003572
Contract(s)/Grant(s): DAAL03-88-C-0002; DAAL03-92-G-0121; NAG2-898; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Several recent applications (in the last five years) of Euler solvers in the computation of impulsive noise from rotor blades emphasize their emerging role in complementing other methods and experimental work. In the area of high-speed impulsive noise the use of Euler solvers as research tools has become fairly mature with very favorable comparisons with experimental data, especially in hover. The grid sizes and resulting computational times are reasonable when compared to those required for accurate surface aerodynamics alone. Furthermore, Euler solvers have provided a rich database with the resolution and accuracy needed for input to Kirchhoff and acoustic analogy methods for predicting the far-field noise. On the other hand, the application of Euler solvers to calculate blade-vortex interaction noise is still far from mature. The computational resources required for accurate calculations away from the blade are much larger than for high-speed impulsive noise. Current calculations help improve the

basic understanding of the phenomena involved, but to date no comparisons with experiment have been made. Fortunately, the use of coupled Euler solver/Kirchhoff methods seems to offer promise for a robust and efficient technique for predicting both high-speed impulsive noise and blade-vortex interaction noise. Finally, a simple model problem of an isolated vortex interacting with an arbitrarily prescribed pitching airfoil demonstrates the feasibility of using Euler solvers to examine noise reduction techniques. The use of simple aerodynamic quasi-static theory and the computed lift time history as feedback to determine the required pitching motion appears sufficient to significantly dampen the unsteady loading and subsequent acoustics by an order of magnitude within a few blade passages.
Author
Aeroacoustics; Aerodynamic Noise; Blade-Vortex Interaction; Computational Grids; Euler Equations of Motion; Far Fields; Helicopters; Hovering; Kirchhoff Law of Radiation; Noise Prediction (Aircraft); Noise Reduction; Pressure Distribution; Rotor Aerodynamics; Rotor Blades

19960003607 Arizona State Univ., Dept. of Mechanical and Aerospace Engineering., Tempe, AZ, United States
ACOUSTIC DESIGN OF ROTOR BLADES USING A GENETIC ALGORITHM
Wells, V. L., Arizona State Univ., USA; Han, A. Y., Arizona State Univ., USA; Crossley, W. A., Arizona State Univ., USA; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 10 p; In English; See also 19960003572; Sponsored in cooperation with McDonnell-Douglas Helicopter Systems
Contract(s)/Grant(s): NAG2-882; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A genetic algorithm coupled with a simplified acoustic analysis was used to generate low-noise rotor blade designs. The model includes thickness, steady loading and blade-vortex interaction noise estimates. The paper presents solutions for several variations in the fitness function, including thickness noise only, loading noise only, and combinations of the noise types. Preliminary results indicate that the analysis provides reasonable assessments of the noise produced, and that genetic algorithm successfully searches for 'good' designs. The results show that, for a given required thrust coefficient, proper blade design can noticeably reduce the noise produced at some expense to the power requirements.
Author
Aeroacoustics; Airfoil Profiles; Blade-Vortex Interaction; Design Analysis; Genetic Algorithms; Helicopters; Low Noise; Noise Prediction; Noise Reduction; Rotor Blades

19960008040 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
AERODYNAMICS OF 3-D AIRCRAFT AFTERBODIES *LAERODYNAMIQUE DES ARRIERE-CORPS TRIDIMENSIONNELS*
Sep 1, 1995; 479p; In English
Report No.(s): AGARD-AR-318; NIPS-95-06219; ISBN 92-836-1023-7; Avail: CASI; A21, Hardcopy; A04, Microfiche

This report presents the findings of a study performed by AGARD Working Group 17 into the current understanding of the aerodynamics of complex 3-D aircraft afterbodies and the status of the methods now available to aid in their design optimization. The major part of the report is given over to the results obtained and lessons learned from the application of current CFD procedures to a selection of test cases ranging in complexity from a simple axisymmetric body with jet to a twin jet body complete with wings and empennage. Comprehensive descriptions of the selected test cases with their experimental data bases are appended to the report in the hope that these will continue to serve other researchers in the field. Other sections of the report review the developments made in empirical/semi-empirical procedures and in the experimental techniques applicable to support both future computational developments and aid directly in the task of aircraft design optimization.
Derived from text
Aerodynamic Characteristics; Afterbodies; Aircraft Design; Design Analysis; Optimization; Three Dimensional Bodies; Three Dimensional Flow

19970009247 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
AEROTHERMODYNAMICS AND PROPULSION INTEGRATION FOR HYPERSONIC VEHICLES *L'INTEGRATION DE LA PROPULSION ET DE L'AERODYNAMIQUE POUR LES VEHICULES HYPERSONIQUES*
Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 422p; In English, 15-19 Apr. 1996, Rhode-Saint-Genese, Belgium; See also 19970009248 through 19970009260
Report No.(s): AGARD-R-813; Copyright Waived; Avail: CASI; A18, Hardcopy; A04, Microfiche

Lecture for the AGARD Fluid Dynamics Panel (FDP) Special Course on 'Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles' have been assembled in this report. The following topics are covered: Aerothermodynamics of radiation-cooled surfaces; real-gas and strong interaction phenomena; hypersonic laminar-turbulent transition and turbulence modeling; configurational aerothermodynamics of reentry vehicles (winged and capsule) as well as RAM and SCRAM propelled vehicles; RAM and SCRAM inlet and propulsion integration; hypersonic missile aerothermodynamics and stage separation for two-stage launch configurations. In addition, the Hypersonic Aerothermodynamic Program at VKI was presented as well as a Navier Stokes-solver for hypersonic applications. The material assembled in this report was prepared under the combined sponsorship of the AGARD Fluid Dynamics Panel, the Consultant and Exchange Program of AGARD, and the von Karman Institute (VKI) for Fluid Dynamics.
Author
Aerothermodynamics; Hypersonic Flow; Stage Separation; Turbulence Models; Computational Fluid Dynamics; Navier-Stokes Equation; Boundary Layer Transition; Supersonic Combustion Ramjet Engines; Flow Distribution

19970018626 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
SUBSYSTEM INTEGRATION FOR TACTICAL MISSILES (SITM) AND DESIGN AND OPERATION OF UNMANNED AIR VEHICLES (DOUAV) *L'INTEGRATION DES SOUS-SYSTEMES DANS LES MISSILES TACTIQUES ET LA CONCEPTION ET L'EXPLOITATION DES VEHICULES SANS PILOTE*
Nov. 1996; 356p; In English; In French, 9-12 Oct. 1995, Ankara, Turkey; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19970018627 through 19970018652
Report No.(s): AGARD-CP-591; ISBN 92-836-0033-9; Copyright Waived; Avail: CASI; A16, Hardcopy; A03, Microfiche

Papers address examples of integrating advanced sensors, guidance control systems, and navigation systems. Methods for testing missiles, including lessons learned from Norway's testing of the Penguin Mk2, are discussed. Design issues, payloads and their associated technologies, and operational issues are examined in relation to Unmanned Air Vehicles (UAV). Specific systems described included: the French Self Contained Early Warning System against anti-ship missiles; the Phoenix; Boeing's heliwing; the Crecelle; and the US Navy's Tilt Rotor UAV demonstrator.
Author
Systems Integration; Missiles; Helicopters; Flight Tests; Integral Rocket Ramjets; Missile Configurations; Aerodynamic Coefficients; Missile Control; Pilotless Aircraft; Conferences

19970019674 Royal Air Force, Royal Air Force Repair Design Authority, Barry, United Kingdom
ROYAL AIR FORCE EXPERIENCE OF MECHANICALLY-FASTENED REPAIRS TO COMPOSITE AIRCRAFT STRUCTURES
Chicken, S. H., Royal Air Force, UK; Jan. 1997; 8p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The RAF has been repairing helicopter composite rotor blades, fiber-glass radomes and panels on a variety of combat aircraft types for many years. However, the Service's main experience in the maintenance of carbon fibre composite (CFC) material has been related to the Harrier 2 aircraft. This paper describes the main CFC structures of

the Harrier 2 and outlines the variety of RAF peace-time, bolted structural repairs applied to the aircraft. Examples are provided of various simple and complex repairs.
Author
Aircraft Maintenance; Aircraft Structures; Composite Structures; Composite Materials; Fighter Aircraft; Glass Fibers; Harrier Aircraft; Maintenance

19970023093 Deutsche Aerospace A.G., Surface Treatment, Munich, Germany
EXPERIENCES IN MAINTENANCE AND OVERHAUL OF MILITARY AIRCRAFT
Unterreiner, Heinz, Deutsche Aerospace A.G., Germany; Stein, Ruth, Mankiewicz Gebr. and Co., Germany; Feb. 1997; 26p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Corrosion as an unavoidable fact requires cost effective control measures. by these control measures, aircraft life will be much longer in comparison with the precautions taken during the manufacturing of a/c. The main philosophy gained by the experiences of maintaining more than 5000 a/c is determined by detection and removal of corrosion, followed by renewal of the protective coating in the very early stages of corrosion. It has to be repeated in determined intervals, based on the lessons learned over the years. A steady development of new coating systems is associated with the elimination of toxic/hazardous chemicals and slower aging of the organics. With respect to human and environment protection, protective coatings, the problems of how to get the higher chemical and mechanical resistant coatings removed, and the goal of collecting all divergent properties under cost effective measures are the guidelines in the aircraft maintenance area.
Author
Aircraft Maintenance; Environment Protection; Protective Coatings; Coating

19970026150 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
HELICOPTER/WEAPON SYSTEM INTEGRATION ***L'INTEGRATION DES SYSTEMES D'ARMES DES HELICOPTERES***
Jul. 1997; 184p; In English, 19-20 May 1997, Winchester, Athens, UK, Greece; See also 19970026151 through 19970026159
Report No.(s): AGARD-LS-209; ISBN 92-836-1055-5; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

This publication includes the papers presented in a NATO Advisory Group for Aerospace Research and Development (AGARD) Lecture Series. This Lecture Series considered the problems of integrating externally mounted weapons on helicopters. The focus is on aeromechanical and structural aspects, with additional discussion on operational issues. It addresses new aspects in the field of helicopter/weapon system integration; it places a strong emphasis on the lessons learned from recent experiences in actual development programs. The publication includes case histories of weapons integration on the AH-64 Apache, the RAH-66 Comanche, the EH-101, and the Tiger.
Author
Helicopters; Systems Integration; Weapon Systems

19970026151 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik, Brunswick, Germany
OVERVIEW
Gmelin, Bernd L., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Helicopter/Weapon System Integration; Jul. 1997; 6p; In English; See also 19970026150; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The helicopter is fast approaching a half century of service as a weapon system. From humble beginnings after World War 2, largely in the roles of observation platforms and search and rescue vehicles, rotorcraft have evolved to a principal in the modern battle scenario. In the war at sea, the helicopter forms an integral part of a task force capable of launching devasting firepower at surface and subsurface targets. In the airland battle, technology has made the helicopter into a tank killer, troop transport and night observation platform. Finally, in the most unlikely arena, air-to-air combat, modern weaponry has shown the helicopter to be effective against even high performance tactical aircraft.
Derived from text
Helicopters; Combat; Weapon Systems; Rotary Wing Aircraft

19970029334 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
LOADS AND REQUIREMENTS FOR MILITARY AIRCRAFT ***LES CHARGES ET LES SPECIFICATIONS DES AVIONS MILITAIRES***
Feb. 1997; 176p; In English; In French; 83rd; AGARD Structures and Materials Panel, 4-5 Sep. 1996, Florence, Italy; See also 19970029335 through 19970029346
Report No.(s): AGARD-R-815; ISBN 92-836-0037-1; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

Since the beginning of aircraft design and certification, loads and loads-related requirements have continued to evolve, while the initial conservative assumptions related to safety factors have remained essentially the same over the years. The technology and analysis tools have also evolved substantially in several areas: for example the increased use of computational/experimental methods in the areas of maneuvering loads; the characterization of buffet; the increased use of stochastic methods for gust loads; and the improved knowledge of fatigue life impact on design. On the other hand, the quest for lighter and higher performance aircraft led to the development of new technologies such as Electronic Flight Control Systems (EFCS) and thrust vectoring systems. With the increased use of these technologies and the improved quantification of factors influencing loads, the initial concept of safety factors and also some of the bases of military standards for military aircraft needed to be re-visited. It was observed in the Workshop that there was not much advantage in trying to reduce the safety factors for a new aircraft but that it might be effective to do so for an aircraft modification after a change of role, for instance. Reserves were also expressed as to the danger of optimizing a design for an initial use. It was considered advisable to remain conservative in order to accommodate changes in role during the life of an aircraft, especially a fighter aircraft. The effects of failures of EFCS on loads envelopes were also presented, showing that in certain cases an aircraft designed according to a functional EFCS could exceed the design load envelope when a failure of EFCS occurred, thus arguing for a certain conservatism in design. It was concluded, that some level of conservatism was still required but that new criteria and methods should be investigated in order to propose standards for future aircraft design.
Author
Aircraft Design; Fighter Aircraft; Loads (Forces); Structural Analysis; Certification; Flight Control; Thrust Vector Control

19970029347 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
ADVANCED ARCHITECTURES FOR AEROSPACE MISSION SYSTEMS ***ARCHITECTURES FUTURES POUR L'AVIONIQUE DE GESTION DE MISSION***
Jul. 1997; 312p; In English; In French; 6th, 14-17 Oct. 1996, Istanbul, Turkey; See also 19970029348 through 19970029377; Original contains color illustrations
Report No.(s): AGARD-CP-581; ISBN 92-836-0044-4; Copyright Waived; Avail: CASI; A14, Hardcopy; A03, Microfiche

This volume contains the Technical Evaluation Report and the 30 unclassified papers, presented at the Mission Systems Panel Symposium held in Istanbul, Turkey, 14-17 October 1996. The papers presented covered the following headings: Invited Papers; Military Applications of Civil Systems; Communications (Systems); Communications (Technology); Surveillance (Reconnaissance); Surveillance (Meteorology); Surveillance (Early Warning); Information Extraction; Vehicle Management; Future Systems and Panel Discussion.
Author
Aerospace Environments; Meteorology; Military Technology; Reconnaissance; Surveillance

19980016571 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
FUTURE AEROSPACE TECHNOLOGY IN THE SERVICE OF THE ALLIANCE, VOLUME 2, MISSION SYSTEMS TECHNOLOGIES ***LES TECHNOLOGIES AERONAUTIQUES ET SPATIALES DU FUTUR AU SERVICE DE L'ALLIANCE ATLANTIQUE, VOLUME 2, LES TECHNOLOGIES DES SYSTEMES DE CONDUITE DE MISSION***
Future Aerospace Technology in the Service of the Alliance; Dec. 1997; 184p; In English; In French; The AGARD Symposium on 'Future Aerospace Technology in the Service of the Alliance', 14-17 Apr. 1997, Palaiseau, France; See also 19980016572 through 19980016587

Report No.(s): AGARD-CP-600-Vol-2; ISBN 92-836-0048-7; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

Advances in sensing and information processing/distribution technologies will enable highly innovative system concepts for achieving unprecedented improvements in military mission capabilities. Assessing those major technology advances, the symposium was structured in five sessions hosting twenty four papers: (1) Mission management concepts, introducing the subject, presenting technological requirements and giving as an example the unmanned tactical aircraft; (2) Sensors and electronic warfare, showing how emerging Radio Frequency and Electro-Optics technologies are able to offer improved situational awareness, but may also defeat apparently reliable weapons; (3) Information and communications systems, stressing the effective blending most likely to occur between market driven and specific military developments, as well as the need to account for the battlespace environment; (4) Information fusion and mission systems integration, demonstrating among others how data fusion which is required for matching the information rate to the human, will result in drastically improving its accuracy and reliability; and (5) System simulation, emphasizing the major role of simulation technologies for cost-effective design of new military systems, evaluation of existing ones, training of operators, and paving the way to the concept of synthetic environments. Based on emerging and rapidly evolving technologies, the presenters built a vision of future weapon systems capable of operating in a diverse range of hostile environments, under all weather conditions, and during day or night. Furthermore, autonomous situation appreciation capability, reliable communication channels and real-time decision aids were discussed, which will drastically reduce the operators' reaction time and prevent overload in a high target and threat density environment. The fruitful interaction with the audience confirmed the unique opportunity offered by this classified symposium to bring together experts working in the relevant sciences as well as the user community, and affiliated either with academia, industry, government organisations, or military services.

Author

Mission Planning; Weapon Systems; Conferences; Electronic Warfare; Military Operations; Systems Engineering; Artificial Intelligence; Decision Making; Pattern Recognition; Global Positioning System; Telecommunication; Aircraft Detection; Avionics

19980018468 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France

AEROSPACE 2020, VOLUME 1 ***AERONAUTIQUE ET ESPACE A L'HORIZON 2020, VOLUME 1***

Dec. 1997; 44p; In French; See also English translation, AGARD-AR-360-Vol-1

Report No.(s): AGARD-AR-360-Vol-1(F); ISBN 92-836-2001-1; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

Volume 1, the summary volume, of the report of the NATO Advisory Group for Aerospace Research and Development (AGARD) study: 'Aerospace 2020'. This study explores the most advanced technologies, relevant to aerospace, being researched and developed in laboratories today. The study focuses on the most promising current technologies and the organizational and tactical consequences they will have at the field and system levels, over the course of the next 25 years. Topics include: a discussion of the impact of proliferation, human-machine interaction, synthetic environments, directed-energy weapons, information technologies, unmanned tactical aircraft, suborbital launchers, hypersonic missiles, and a discussion of affordability issues. Technologies are assessed from the viewpoints of both potential capabilities and threats. Observations and recommendations are presented.

Author

Aerospace Engineering; Weapon Systems; North Atlantic Treaty Organization (NATO); Man Machine Systems; Hypersonics; Pilotless Aircraft; Fighter Aircraft

19980018672 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France

FUTURE AEROSPACE TECHNOLOGY IN THE SERVICE OF THE ALLIANCE, VOLUME 3, SUSTAINED HYPERSONIC FLIGHT ***LES TECHNOLOGIES AERONAUTIQUES ET SPATIALES DU FUTUR AU SERVICE DE L'ALLIANCE ATLANTIQUE, VOLUME 3, LE VOL EN CROISIERE HYPERSONIQUE***

Dec. 1997; 432p; In French; In English; AGARD Symposium on ' Future Aerospace Technology in the Service of the Alliance', 14-17 Apr. 1997, Palaiseau, France; See also 19980018673 through 19980018705

Report No.(s): AGARD-CP-600-Vol-3; ISBN 92-836-0049-5; Copyright Waived; Avail: CASI; A19, Hardcopy; A04, Microfiche

Sustained Hypersonic Flight capability is envisioned for several future military and civilian applications, such as long range immediate reaction reconnaissance, high speed interception of air targets, long range precision strike against hardened or time critical targets, and access to space. The inherent reduction in time-to-target and low vulnerability will permit new operational tactics. The symposium outlined mission needs and operational scenarios for hypersonic vehicles. Addressed were: Technological issues and challenges in external hypersonic aerodynamics and design, propulsion and engine/airframe integration, military ramjet applications, overall system design including structures and materials development needs, and test facilities. Ground based test facilities cannot provide full simulation at Mach numbers above 5. Therefore, the use of Computational Fluid Dynamics design tools is essential. For routine use of the computational tools in analysis, design and optimization, it is necessary to reduce the time for the entire computational process by two orders of magnitude. Hypersonic boundary layer transition remains a critical design issue because of the important impact on engine drag and on heating, which can affect the choice of materials and thermal protection systems. In addition, reliable prediction of scramjet net thrust is an absolute must in resolving hypersonic air breathing vehicle design issues. Due to current facility and computational shortfalls, the development of future hypersonic flight systems requires research flight tests in the technology areas of boundary layer transition and air-breathing propulsion engine performance. For sustained hypersonic flight beyond Mach 6, the supersonic combustion ramjet (scramjet) engine is the only choice for the near future. Only this air-breathing concept offers a significant promise of large reductions in required propellant fractions, increased payload fractions, and reduced size vehicles, together with a foreseeable technological feasibility. Airframe/engine integration, combustor design and thermal management are the predominant engineering tasks. Fuels, hydrogen or hydrocarbon, must be matched to the operational needs of military or civil use. Experience in existing ramjet propelled missiles capable of speeds up to Mach 4 can support the development effort. The potential mission and cost benefits of sustained hypersonic flight to both military and civil applications are tremendous. From the budget point of view, the possibility of sharing development costs between military and civil programs offers a specific advantage.

Derived from text

Aerodynamics; Hypersonic Flight; Systems Engineering; Software Development Tools; Military Operations; Military Technology; Engine Airframe Integration; Design Analysis; Air Breathing Engines; Boundary Layer Transition; Flight Tests

19980033517 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France

FUTURE AEROSPACE TECHNOLOGY IN THE SERVICE OF THE ALLIANCE, VOLUME 1, AFFORDABLE COMBAT AIRCRAFT AND PLENARY SESSIONS ***LES TECHNOLOGIES AERONAUTIQUES ET SPATIALES DU FUTUR AU SERVICE DE L'ALLIANCE ATLANTIQUE, VOLUME 1, LE COUT DE POSSESSION DES AVIONS DE COMBAT***

Future Aerospace Technology in the Service of the Alliance; Dec. 1997; 310p; In French; In English; Future Aerospace Technology in the Service of the Alliance, 14-17 Apr. 1997, Palaiseau, France; See also 19980033518 through 19980033540

Report No.(s): AGARD-CP-600-Vol-1; ISBN 92-836-0047-9; Copyright Waived; Avail: CASI; A14, Hardcopy; A03, Microfiche

One of three volumes containing the unclassified papers presented at a conference on "Future Aerospace Technology in the Service of the Alliance" organised by AGARD (NATO's Advisory Group for Aerospace Research and Development) at Palaiseau, near Paris, France, 14-17 April 1997. The conference took the form of three parallel symposia and three plenary sessions. This volume contains the papers from the three plenary sessions: Future Directions in Aerospace Systems Future NATO Trends and Mission Scenarios Human Machine Interaction in the Future and the symposium on "Affordable Combat Aircraft", which had sessions on: Affordability of Procurement, Combat Effectiveness, Affordability of Ownership, The Human

Element. Volume 2 contains the papers on "Mission Systems Technologies". Volume 3 contains the papers on "Sustained Hypersonic Flight".
Author
Fighter Aircraft; North Atlantic Treaty Organization (NATO); Combat; Hypersonic Flight; Aerospace Systems

19980033535 Dassault Aviation, Saint-Cloud, France
REDUCING MAINTENANCE COSTS FOR COMBAT AIRCRAFT AIR FRAMES *LA REDUCTION DES COUTS DE MAINTENANCE DES CELLULES D'AVIONS DE COMBAT*
Chaumette, Daniel, Dassault Aviation, France; Armando, Patrick, Delegation Generale de l'Armement, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 12p; Summary translated by Schreiber; In French; See also 19980033517; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Maintaining a fleet of combat aircraft ready for operational employment for a group of missions with a fixed availability rate according to all evidence requires that all aircraft, during their service life, be subject to maintenance and inspection, or to repair or replacement; all of these activities are essential for flight safety. Different maintenance situations arise as a function of the critical nature and reliability of the systems involved, the scope of operations and their periodicity, as well as the required resources and skills. In this case, maintenance will be of the programmed type, i.e., of the planned type, and/or it will be unprogrammed and will focus on the air frame, the engine, the systems, and the equipment.
Derived from text
Aircraft Maintenance; Cost Reduction; Service Life; Reliability; Fighter Aircraft; Airframes

19980035004 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
ADVANCES IN FLIGHT TESTING *LES AVANCEES DANS LE DOMAINE DES ESSAIS EN VOL*
Dec. 1997; 400p; In French; Flight Vehicle Integration Panel Symposium, 23-26 Sep. 1996, Lisbon, Portugal; See also 19980035005 through 19980035034
Report No.(s): AGARD-CP-593; ISBN 92-836-0050-9; Copyright Waived; Avail: CASI; A17, Hardcopy; A04, Microfiche

The Symposium comprised six sessions, each being devoted to a particular field, with one session on Systems Evaluation, including avionics, navigation, propulsion and weapons aspects, two sessions on Technological Advances covering all technical fields such as avionics software, simulation, instrumentation, aerodynamics, test methods etc., one session devoted to an Overview of Current Programmes, one session on Flight Dynamics, incorporating handling qualities, performance and flight controls, and one session addressing Management Problems in Testing. The symposium closed with a discussion between government representatives and manufacturers on "The role of governments in development testing in the 21st century".
Author
Conferences; Computerized Simulation; Aerodynamics; Avionics

19980035005 Flight Test Squadron (418), DOEAC, Edwards AFB, CA United States
C-17A AVIONICS FLIGHT TEST PROGRAM
MacLean, William J., Flight Test Squadron (418), USA; Dublenko, A. Lawrence, Aerospace Engineering Test Establishment, Canada; Advances in Flight Testing; Dec. 1997; 16p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

To date, the C-17A is one of the most advanced military airlift aircraft in the world. The corresponding avionics have reduced the number of crew members in the cockpit from four to two, and at the same time have increased the pilot's awareness of his aircraft's capabilities. The DT&E avionics program introduced many challenges to efficiently and adequately test the system to a high level of confidence before releasing the capability to the user. The use of effective test team structure helped to make the test program as efficient as possible, and the many lessons learned were incorporated into the program as testing progressed. As complex as the C-17A avionics suite is, it is a highly capable system with room for growth to increase future capability. In December 1979, the USA Department of Defense launched the Cargo-Experimental (CX) program to define the capabilities needed in a new strategic airlift aircraft. The result was the C-17A Globemaster III which incorporates supercritical airfoil technology and winglets for long-range cruise performance as well as large externally blown flaps, full-span leading edge slats, spoilers, high sink-rate landing gear, anti-skid braking, and thrust reversers for rapid tactical descent and enhanced performance at short airfields. Further, the advanced C-17A integrated avionics suite, which consists of more than 60 remote terminals on nine different MIL-STD1553 busses, enables an aircrew of only two pilots and one loadmaster to carry out the C-17A long range heavy airlift mission. Test mission planning, test conduct, and analysis used both traditional and new test techniques to successfully accomplish the test mission. Lessons learned have been mostly m the realm of test planning and preparation. The sheer number of test points for the entire program (8000 total) and the manner in which testing was divided into aircraft systems contributed to inefficiencies in test flights. The C-17A avionics flight test program introduced many challenges to efficiently and adequately test a complex integrated avionics system to a high level of confidence before releasing capability to the user. The use of an effective test team structure and test planning helped to make the test program as efficient as possible, with many lessons learned being incorporated into the program as testing progressed. As complex as the C-17A avionics suite is, it is a highly capable system with room for growth to increase future capability.
Author
Flight Tests; Test Facilities; Mission Planning; Leading Edge Slats; Landing Gear; Flight Crews; Antiskid Devices; Airfoils

19980202469 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
NUMERICAL UNSTEADY AERODYNAMIC AND AEROELASTIC SIMULATION *L'AERODYNAMIQUE INSTATIONNAIRE NUMERIQUE ET LA SIMULATION DE L'AEROELASTICITE*
Numerical Unsteady Aerodynamic and Aeroelastic Simulation; Mar. 1998; 198p; In English; In French; Meeting of the AGARD Structures and Materials Panel, 14-15 Oct. 1997, Aalborg, Denmark; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19980202470 through 19980202483
Report No.(s): AGARD-R-822; ISBN 92-836-0054-1; Copyright Waived; Avail: CASI; A09, Hardcopy; A03, Microfiche

Two components are required for analysis of dynamic aeroelastic phenomena, a structural finite element model of the vehicle, and an unsteady aerodynamics model; in current practice linear approximations are used for both models. Although structural nonlinearities possibly play a part in some cases of Limit Cycle Oscillation (LCO), the analysis community is generally content with existing structural modeling methods. The need for accurate and user-friendly advanced aerodynamic methods, however, is generally recognized. Control surface buzz, a one degree of freedom aeroelastic phenomenon involving shock oscillation, is an example of a problem not susceptible to analysis using linear aerodynamics. The current practice in industry is to use very conservative rules of thumb in hopes of preventing buzz, or simply to ignore the possibility. Obviously, conservatism introduces unnecessary weight and the discovery of a buzz problem during the test program causes delay and an expensive redesign effort. As computer hardware increases in capability, CFD methods are maturing and becoming available for at least limited use in industry. These methods hold much hope for future improvements in unsteady aerodynamics predictions. More accurate analysis of ordinary flutter in the sub- and supersonic flight regimes as well as the development of transonic analysis methods can result in a reduction of aircraft weight and development cost by reducing the need for conservatism and possibly by eliminating the expense of flutter model testing. Up to the present time, extreme difficulty of use, computational cost and lack of verification against suitable test cases have severely limited use of CFD procedures in industry; codes suitable for analysis of complete aircraft have not been shown to exist. The papers at this Workshop dealt with methods at the leading edge of current technology as applied in industry, and with more advanced methods which are in the development and checkout process. These papers contribute to the

expectation that the time is not far removed when industry will be able to make much increased use of advanced unsteady aerodynamics methods.
Author
Unsteady Aerodynamics; Mathematical Models; Finite Element Method; Aeroelasticity; Computational Fluid Dynamics; Navier-Stokes Equation; Three Dimensional Flow; Computerized Simulation; Flutter

19980203985 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
ADVANCED AERODYNAMIC MEASUREMENT TECHNOLOGY ***TECHNOLOGIES AVANCEES DE MESURE AERODYNAMIQUE***
Advanced Aerodynamic Measurement Technology; May 1998; 420p; In English; In French; 81st; Fluid Dynamics Panel Symposium, 22-25 Sep. 1997, Seattle, WA, USA; See also 19980203986 through 19980204020; Original contains color illustrations
Report No.(s): AGARD-CP-601; ISBN 92-836-0056-8; Copyright Waived; Avail: CASI; A18, Hardcopy; A04, Microfiche

The papers prepared for the AGARD Fluid Dynamics Panel (FDP) Symposium, "Advanced Aerodynamic Measurement Technology" are contained in this report. In addition, a Technical Evaluator's Report aimed at assessing the success of the Symposium in meeting its objectives, and an edited transcript of the General Discussion held at the end of the Symposium are also included. Measurement techniques were presented for flows from subsonic to hypersonic Mach numbers and environments from cryogenic to high-enthalpy reacting flows. Papers presented during the sessions addressed the following subjects: Particle Image Velocimetry; Doppler Global Velocimetry; Molecular Diagnostic Techniques; Holographic Interferometry; Skin Friction Measurements; Pressure Sensitive Paints; and Balance and Model Deformation Measurements.
Author
Aerodynamics; Particle Image Velocimetry; Skin Friction; Mechanical Measurement; Flow Visualization; Conferences; Measuring Instruments; Wind Velocity Measurement; Flow Measurement; Wind Tunnels; Flow Characteristics

19990007836 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
SYSTEM DESIGN CONSIDERATIONS FOR UNMANNED TACTICAL AIRCRAFT (UTA) ***LES CONSIDERATIONS DANS LES PROJECTS DE SYSTEMES POUR LES AERONEFS TACTIQUES ET NON PILOTES***
Jul. 1998; 292p; In English; In French; 8th; Mission Systems Panel Symposium, 7-9 Oct. 1997, Athens, Greece; See also 19990007837 through 19990007863; Original contains color illustrations
Report No.(s): AGARD-CP-594; ISBN 92-836-0057-6; Copyright Waived; Avail: CASI; A13, Hardcopy; A03, Microfiche

This volume contains the Technical Evaluation Report, the Keynote Address and the 26 unclassified papers, presented at the Mission Systems Panel 8th Symposium held in Amfithea (Athens) Greece from 7th to 9th October 1997. The papers presented covered the following headings: (1) Applications; (2) Operational Concepts I & II; (3) Advances in UTA Techniques and Technologies (NAV, C(sup 3)I, G&C); and (4) Advances in UTA Techniques and Technologies (Sensors, Processing, Data Fusion).
Author
Conferences; Pilotless Aircraft; Systems Engineering; Aircraft Design; Tacan

19990007842 Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX United States
DESIGN CONSIDERATIONS FOR FUTURE UNIHABITED COMBAT AIR VEHICLES
Chaput, Armand J., Lockheed Martin Tactical Aircraft Systems, USA; Jul. 1998; 12p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A potential shortfall in U.S. tactical aircraft inventories required to meet future national and international defense contingency requirements early in the next century is projected to materialize some time during the period 2005-2015. The Uninhabited Combat Air Vehicle (UCAV) system concept has potential to help resolve the projected inventory shortfall. Lockheed Martin Tactical Aircraft Systems (LMTAS) studies have identified a number of potential roles and missions in which the UCAV should he both cost and operationally effective. The UCAV concept, however, is unproven and needs system concept technology development, evaluation and demonstration if it is to be considered a viable candidate to meet the projected shortfall. A near-term development program that includes overall system simulation, evaluation and demonstration in combination with configuration specific and advanced technology development (ATD) will ensure that defense planners have a viable alternative ready for decision by the time the projected shortfall materializes.
Author
Pilotless Aircraft; Remotely Piloted Vehicles; Design Analysis; Systems Integration; Systems Analysis; Fighter Aircraft

19990014353 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
AEROSPACE 2020, VOLUME 3, BACKGROUND PAPERS ***AERONAUTIQUE ET ESPACE A L'HORIZON 2020, VOLUME 3***
Aerospace 2020; Sep. 1997; 148p; In English; See also 19990014354 through 19990014383
Report No.(s): AGARD-AR-360-Vol-3; ISBN 92-836-1059-8; Copyright Waived; Avail: CASI; A07, Hardcopy; A02, Microfiche

Volume III is comprised of the technical papers supporting the report of the NATO Advisory Group for Aerospace Research and Development (AGARD) study: "Aerospace 2020". This study explored the most advanced technologies, relevant to aerospace, being researched and developed in laboratories today. The study focused on the most promising current technologies and the organizational and tactical consequences they will have at the field and system levels, over the course of the next 25 years. Topics include: a discussion of the impact of proliferation, human-machine interaction, synthetic environments, directed-energy weapons, information technologies, unmanned tactical aircraft, suborbital launchers, hypersonic missiles, and a discussion of affordability issues. Technologies are assessed from the viewpoints of both potential capabilities and threats. Observations and recommendations are presented. Volume II contains the conclusions of the report. Volume I is a short summary of these conclusions.
Author
Aerospace Engineering; Technology Assessment; Fluid Dynamics; Mission Planning; Aircraft Design; Weapon Systems; Hypersonic Aircraft; Human Factors Engineering; Man Machine Systems

02
AERODYNAMICS

19960003575 Naval Postgraduate School, Navy-nasa Joint Inst. of Aeronautics., Monterey, CA, United States
COMPRESSIBILITY EFFECTS ON DYNAMIC STALL OF OSCILLATING AIRFOILS
Chandrasekhara, M. S., Naval Postgraduate School, USA; Carr, L. W., Army Aviation Systems Command, USA; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 15 p; In English; See also 19960003572; Sponsored in cooperation with AFOSR
Contract(s)/Grant(s): ARO-MIPR-114-91; ARO-MIPR-132-92; ARO-MIPR-125-93; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A review of experimental results from an ongoing study of the effects of compressibility on dynamic stall of an oscillating NACA 0012 airfoil is presented. The study shows that compressibility effects become significant at a free stream Mach number of 0.3. Dynamic stall is accelerated above this Mach number, but increasing unsteadiness delays onset of stall even under compressible flow conditions. Interferometric images of the flow show that process of dynamic stall occurs rapidly over a small angle of attack range. For certain flow conditions, multiple shocks form in the flow near the airfoil leading edge. The delay of stall has been shown to be due to delayed development combined with modification of the adverse pressure gradient in the flow. Transition has been shown to significantly modify the observed flow

behavior, and thus is a very important factor to be considered, especially since it occurs near the vortex formation location. Proper modelling of its effects is critical to dynamic stall flow computations.
Author
Aerodynamic Stalling; Airfoils; Angle of Attack; Compressibility Effects; Compressible Flow; Computational Fluid Dynamics; Flow Distribution; Helicopters; Leading Edges; Pressure Gradients; Rotor Aerodynamics; Subsonic Speed

19960003576 Turkish Aerospace Industries, Advanced Design Dept., Ankara, Turkey
EFFECT OF TURBULENCE MODELING ON DYNAMIC STALL COMPUTATIONS
Dindar, Mustafa, Turkish Aerospace Industries, Turkey; Kaynak, Unver, Turkish Aerospace Industries, Turkey; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 11 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Dynamic stall phenomenon was studied numerically to investigate effects of turbulence modeling. An unsteady Navier-Stokes code capable of solving flow field around an airfoil undergoing unsteady harmonic motion was used for this purpose. A comparative study conducted between equilibrium and nonequilibrium turbulence models. It was found that, nonequilibrium effects play an important role in determining the separation and vortex shedding mechanisms of dynamic stall. First of all, in light stall, inadequacy of equilibrium models defeated by including nonequilibrium effects, and only Johnson-King model could be able to produce light stall hysteresis loop that is similar to experiment. Secondly, in the deep stall regime, vortex shedding mechanism was found to be greatly influenced by turbulence model.
Author
Aerodynamic Stalling; Airfoils; Computational Fluid Dynamics; Flow Distribution; Helicopters; Navier-Stokes Equation; Rotor Aerodynamics; Turbulence Models; Vortex Shedding

19960003577 Mil Moscow Helicopter Plant, Aerodynamics Section., Moscow, Russia
INVESTIGATION INTO EFFECT PRODUCED BY BLADE AIRFOIL UNSTEADY AIRFLOW ON HELICOPTER MAIN ROTOR POWER REQUIRED
Ivtchin, V. A., Mil Moscow Helicopter Plant, Russia; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 8 p; In English; See also 19960003572; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The paper presents the results obtained from the analysis of experimental data on the profile drag for pitch oscillating airfoils, as well as the technique developed for application of these data in calculations of helicopter main and tail rotors. The effect of the unsteady airflow on the profile drag was not taken into account. The reason is that it is very difficult to obtain experimental data. The existing analytical techniques of obtaining unsteady airfoil aerodynamic characteristics in a drained wing section allowed to determine only an average per cycle value of the profile drag. The problem of defining the profile drag of pitch oscillating airfoils has been more completely solved by V.E. Baskin. He has developed and successfully applied his unique method of defining aerodynamic characteristics of airfoils oscillating in the airflow. This approach has allowed to determine not only the pitch moment and lift values, but the instantaneous value of the profile drag as well. The data obtained from the experiments has been used to develop a method capable of calculating rotor shaft horsepower with due account of the profile drag characteristics. The analysis for forward flight conditions has been made by using the main rotor disc vortex theory. It has taken due account of the values of the pitch oscillating airfoil lift coefficient as well. The paper presents comparison of the instantaneous profile drag values versus the angle of attack data obtained from calculations and experiments.
Author
Aerodynamic Drag; Air Flow; Airfoils; Angle of Attack; Helicopters; Rotor Aerodynamics; Unsteady Aerodynamics; Unsteady Flow

19960003578 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Fluid Mechanics., Goettingen, Germany
DYNAMIC STALL CONTROL BY VARIABLE AIRFOIL CAMBER
Geissler, W., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Sobieczky, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 10 p; In English; See also 19960003572; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

In the present numerical investigations the unsteady flow about a helicopter airfoil section under deep dynamic stall conditions has been influenced by dynamic airfoil deformation. First attempts with a dynamic variation of the airfoil thickness have already shown the favorable effects on the dynamic stall phenomenon: the dynamic stall onset could be shifted to considerably higher incidences within the oscillatory loop. In the present paper the extension of this method to more arbitrary types of dynamic deformations is discussed and the influence of a dynamic change of he airfoil leading edge curvature (nose droop) is investigated in detail. Special emphasis is placed on the variation of the Mach number. It is shown that for incompressible flow (M-alpha(sub infinity) = 0.1) the shedding of a dynamic stall vortex can be avoided at all. At a slightly higher Mach number (M-alpha(sub infinity) = 0.3) however the complete suppression of the dynamic stall vortex is a much more difficult task. The present results show the way how to proceed successfully also in the compressible flow cases. Further is is obvious that the concept of deforming airfoils has considerable potential in other areas of helicopter aerodynamics, i.e. reduce or even avoid shock motion on the advancing side and therefore reduce the problem of compressibility noise radiation.
Author
Aerodynamic Stalling; Airfoils; Camber; Compressible Flow; Computational Fluid Dynamics; Grid Generation (Mathematics); Helicopters; Leading Edges; Mach Number; Navier-Stokes Equation; Rotor Aerodynamics; Unsteady Aerodynamics; Unsteady Flow; Vortex Shedding

19960003579 Netherlands Energy Research Foundation, Petten, Netherlands
REVIEW OF RECENT AERODYNAMIC RESEARCH ON WIND TURBINES WITH RELEVANCE TO ROTORCRAFT. DATA (AND RIDDLES) ON DYNAMIC INFLOW, FLOW FIELD OF YAWED ROTORS, AND ROTATING 3-D STALL
Snel, H., Netherlands Energy Research Foundation, Netherlands; Vanholten, TH., Technische Univ., Netherlands; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 11 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A review is given of recent research on the aerodynamics of wind turbine rotors. The following subjects are covered in detail: (1) The induced velocity field of rotors, including dynamic inflow and yawed flow effects; and (2) Stall delay on rotation blades. A new boundary layer formulation is outlined applicable to this phenomenon. Without any further discussion, also some references have been given concerning recent wind turbine research on: (1) simulation methods of atmospheric turbulence; (2) dynamic stall effects, comparisons between theory and experiments; and (3) effect of several types of blade tips on radiated noise.
Author
Axial Flow; Boundary Layers; Flow Distribution; Pressure Distribution; Rotating Stalls; Rotor Aerodynamics; Turbine Blades; Velocity Distribution; Wind Turbines; Yawing Moments

19960003580 Arrow Research, Montreal Quebec, Canada
DYNAMIC STALL SIMULATION APPLIED TO VERTICAL-AXIS WIND TURBINES
Tchon, Ko Foa, Arrow Research, Canada; Halle, S., Ecole Polytechnique, Canada; Paraschivoiu, Ion, Ecole Polytechnique, Canada; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 10 p; In English; See also 19960003572
Contract(s)/Grant(s): EMRC-23440-0-9457/01-SS; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The dynamic stall on a NACA 0015 airfoil performing a rotation motion characteristic of Darrieus vertical-axis wind turbines is simulated using laminar and turbulent Navier-Stokes solvers. The numer-

ical results are compared with experimental data and show the importance of an adequate turbulence model to realistically simulate such a phenomenon. The differences between a Darrieus rotation motion and a pure pitching motion are also discussed.
Author
Aerodynamic Stalling; Airfoils; Computational Fluid Dynamics; Finite Element Method; Grid Generation (Mathematics); Navier-Stokes Equation; Pressure Distribution; Rotor Aerodynamics; Turbulence Models; Turbulent Flow; Velocity Distribution; Wind Turbines

19960003581 Risoe National Lab., Test Station for Wind Turbines., Roskilde, Denmark
STALL HYSTERESIS AND 3D EFFECTS ON STALL REGULATED WIND TURBINES: EXPERIMENT AND MODELLING
Madsen, H. A., Risoe National Lab., Denmark; Rasmussen, F., Risoe National Lab., Denmark; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 9 p; In English; See also 19960003572; Sponsored by the Danish Ministry of Energy; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The stall regulation is used for control of maximum power and loads on a major part of wind turbines today of sizes up to 50-60 m in diameter. Operation with the blades partially or fully stalled is for this type of machines a part of their normal operating regime. Aeroelastic calculations below stall using 2D airfoil data give satisfactory results but in stall and above stall the calculations indicate self excited flapwise vibrations. Fortunately, they are not in general confirmed by measurements. This discrepancy seems to be due to dynamic stall effects and the 3D airfoil characteristics for the rotating blade. Such airfoil characteristics have been measured on a 19 m stall regulated rotor and the deviations from 2D data are considerable. High normal force coefficients are measured at the root end and the lift curve has no negative slope up to 25-30 deg. angle of attack. Considerable stall hysteresis has been measured in normal operation and in particular during yawed operations. Measurements in a 4x4 m wind tunnel on the same blade has been carried ot in order to determine the airfoil characteristics without the influence of rotation. This comparison indicates that rotational effects are of some importance for the discrepancy between 2D and 3D data. A CFD calculation on a simplified model of a rotating blade and at a low Reynolds number indicates that rotation does reduce the thickness of the separated boundary layer, resulting in the increased lift. Although the use of a stall hysteresis model in aeroelastic calculations generates damping and eliminates the selfexcited vibrations, the problem still is to predict dynamic stall events, which have the correct power spectral characteristics.
Author
Aerodynamic Stalling; Aeroelasticity; Airfoils; Angle of Attack; Boundary Layer Separation; Computational Fluid Dynamics; Grid Generation (Mathematics); Low Reynolds Number; Rotor Aerodynamics; Turbine Blades; Unsteady Flow; Wind Tunnel Tests; Wind Turbines

19960003583 National Technical Univ., Dept. of Mechanical Engineering., Athens, Greece
INVESTIGATION OF THE YAWED OPERATION OF WIND TURBINES BY MEANS OF A VORTEX PARTICLE METHOD
Voutsinas, S. G., National Technical Univ., Greece; Belessis, M. A., National Technical Univ., Greece; Rados, K. G., National Technical Univ., Greece; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 11 p; In English; See also 19960003572
Contract(s)/Grant(s): JOU2-CT92-0186; JOU2-CT92-0113; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A fully three-dimensional non-linear aeroelastic numerical investigation of the response of horizontal axis wind turbines during yawed operation was carried out. The numerical tool used, consists of a time-marching method based on the coupling of an unsteady free-wake vortex particle model and a 3D beam-type structural model. The investigation led to a complete data base of numerical results concerning the Tjaereborg wind turbine for which extensive full scale measurements of very good quality exist. Among the points that were given particular attention are: the effect of the root vortex, the coupling with the shear of the inflow and the tower effect on the dynamics of the blades. Herein the most significant results are presented and discussed.
Author
Aeroelasticity; Computational Fluid Dynamics; Flow Distribution; Grid Generation (Mathematics); Rotor Aerodynamics; Time Marching; Turbine Blades; Unsteady Flow; Velocity Distribution; Vortices; Wind Turbines; Yaw

19960003584 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
METHODS FOR COMPUTATION APPLIED TO HELICOPTER ROTORS BY ONERA *METHODES DE CALCUL AERODYNAMIQUE APPLIQUESS AUX ROTORS D'HELICOPTERES A L'ONERA*
Costes, M., Office National d'Etudes et de Recherches Aerospatiales, France; Beaumier, P., Office National d'Etudes et de Recherches Aerospatiales, France; Gardarein, P., Office National d'Etudes et de Recherches Aerospatiales, France; Zibi, J., Office National d'Etudes et de Recherches Aerospatiales, France; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 15 p; In French; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents the aerodynamic methods which are used currently at the Applied Aerodynamics Department of ONERA for the computation of helicopter rotors in hover and forward flight. They cover a wide range of algorithms, from classical blade element theory to more complex unsteady three-dimensional methods, each of them being well adapted to deal with a particular problem related to the helicopter main rotor. Typical applications for blade loads and dynamics, wake geometry, pressure distribution, performance prediction and parametric optimization are shown. Finally, the future trends in terms of CFD applications in the field of helicopter rotors at ONERA are given.
Author
Computational Fluid Dynamics; Grid Generation (Mathematics); Helicopters; Horizontal Flight; Hovering; Pressure Distribution; Rotor Aerodynamics; Unsteady Flow

19960003585 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Design Aerodynamics., Brunswick, Germany
THREE-D EULER CALCULATIONS OF MULTIBLADED ROTORS IN HOVER: INVESTIGATION OF THE WAKE CAPTURING PROPERTIES
Raddatz, J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Pahlke, K., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 16 p; In English; See also 19960003572
Contract(s)/Grant(s): IMT PROJ. AERO-2017/2060; PROJ. HELISHAPE; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The 3D flowfield of a hovering rotor is calculated solving the Euler equations. Performing a grid refinement study it is demonstrated that an Euler method is able to capture the wake and vortices of a hovering rotor without any wake modelling. Accurate prediction of these rotational flow field phenomena needs fine grids with a high resolution in the complete region of the wake system. Additionally, high accuracy for the treatment of all numerical boundaries, which affect the vortex wake, is required. On the other hand, the investigations have shown that surface airloads are less effected by a more detailed resolution of the wake system. A second part of the study is concerned with wake capturing properties on block boundaries, especially on inner boundaries of overlapping grids. Overlapping grids are very attractive for the computation of a rotor in lifting forward flight or a rotor-body flowfield in hover. The effect of overlapping grids using the chimera technique is investigated comparing Euler solutions for a hovering rotor on a chimera grid system and on conventional single block and two block calculations. The chimera solution reproduces all flow features. The present implementation shows disadvantages concerning the detailed resolution of the wake system.
Author
Computational Fluid Dynamics; Computational Grids; Euler Equations of Motion; Flow Distribution; Flow Visualization; Grid Generation (Mathematics); Helicopter Wakes; Helicopters; Hovering; Navier-Stokes Equation; Rotor Aerodynamics; Runge-Kutta Method; Vortices

19960003588 Stuttgart Univ., Inst. fuer Aerodynamik und Gasdynamik.; **Germany**
COST EFFICIENT CALCULATION OF COMPRESSIBLE POTENTIAL FLOW AROUND A HELICOPTER ROTOR INCLUDING FREE VORTEX SHEET BY A FIELD PANEL METHOD
Roettgermann, A., Stuttgart Univ., Germany; Wagner, S., Stuttgart Univ., Germany; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 10 p; In English; See also 19960003572
Contract(s)/Grant(s): DFG-WA424/8; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

To consider compressible transonic effects a vortex lattice method for the computation of the rotor flow is coupled with a field panel method. For this purpose Cartesian grids are used which are not adapted to the contour and only discretize the domain of the nonlinear flow. The basis for this procedure is the separation of the full potential equation into the Laplacian operator and the nonlinear terms. The developed program ROFPM is validated at several test cases of the CARADONNA rotor.
Author
Blade-Vortex Interaction; Compressible Flow; Computational Fluid Dynamics; Computational Grids; Helicopters; Panel Method (Fluid Dynamics); Potential Flow; Rotary Wings; Rotor Aerodynamics; Transonic Flow; Vortex Lattice Method; Vortex Sheets

19960003589 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
EVALUATION OF AERODYNAMIC AND DYNAMIC MODELS OF THE ROTORS OF HELICOPTERS BY CONFRONTATION TO THE EXPERIMENT *EVALUATION DE MODELES AERODYNAMIQUES ET DYNAMIQUES DES ROTORS D'HELICOPTERES PAR CONFRONTATION A L'EXPERIENCE*
Bessone, J., Office National d'Etudes et de Recherches Aerospatiales, France; Petot, D., Office National d'Etudes et de Recherches Aerospatiales, France; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 9 p; In French; See also 19960003572; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This article presents the code of research 'ROTOR' developed with the ONERA and applied to the aeroelastic study of the rotors of helicopters. Confrontations of ROTOR with the experiment are then addressed. The core of the code calculates the equations of Lagrange associated with the rotor. Around various modules appear: methods of resolution, dynamic and aerodynamic models, formulations induced speeds. The structure of the rotor is regarded as a succession of basic transformations and the originality of ROTOR lies in the direct and automatic writing of the equations in matrix form. The confrontation of ROTOR with the experiment, first of all, showed the need for a very realistic modeling of the swirling wake. Locally, the dynamic model of stall ONERA clarifies very well the phenomenon of stall, improves calculations appreciably, but does not always allow to reach the experimental lift. The introduction into ROTOR of the semi-empirical correction of Houwink reduces the deficit of lift in the area of the strong stalls. Moreover, at the time of preliminary results, the models of Hopf reveal the oscillatory phenomena of the lift observed in experiments in this area. But the use of non-rectangular tips of blade will require, for the calculation of the effort aerodynamics buildings and of the deformations of blade, a finer analysis of the three-dimensional effects of end that only an aerodynamics of the CFD type seems to be able to estimate correctly.
Author
Aerodynamic Stalling; Aeroelasticity; Applications Programs (Computers); Helicopters; Lift; Rotary Wings; Rotor Aerodynamics; Turbulent Wakes

19960003595 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. for Fluid Mechanics., Goettingen, Germany
FLOW FIELD INVESTIGATION OF A ROTATING HELICOPTER ROTOR BLADE BY THREE-COMPONENT LASER-DOPPLER-VELOCIMETRY
Seelhorst, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Beesten, B. M. J., Technische Univ., Germany; Buetefisch, K. A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 12 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The measurement of three dimensional local flow vectors of a blade tip vortex at positions near the helicopter rotor plane were performed with a three component laser-Doppler-velocimeter (3D LDV). A 'position monitoring system' synchronized to the blade rotation gave access to blade motion parameters like lead-lag and pitching at the desired radial position of the blade. Mainly results concerning the structure of blade tip vortices were obtained. The measurements of a vortex generated at hover condition showed the correctness of 'time history' data acquisition, e.g. taking data during the time interval when one particular blade is passing the location of the measuring volume of the LDV. Vortex structure measurements at two different blade tips, a regular square tip for reference and a non-planar tip called winglet, were carried out. First of all the influence of the winglets on vortex structure and blade vortex interaction (BVI) has been investigated. Then in addition to the vortex parameters like vortex/blade miss distance, vortex core size, axial velocity deficit, vortex strength, and vorticity distribution with respect to the spatial orientation of the vortex axis, results on 3D-vorticity distribution and the temporal vortex roll up for the different blade tip vortices have been obtained.
Author
Blade Tips; Blade-Vortex Interaction; Flight Simulation; Flow Distribution; Horizontal Flight; Hovering; Rotary Wing Aircraft; Rotary Wings; Three Dimensional Flow; Vorticity; Wind Tunnel Tests

19960003600 Rome Univ., Dipt. di Meccanica e Automatica., Rome, Italy
A BOUNDARY INTEGRAL METHOD FOR UNIFIED TRANSONIC AERODYNAMIC AND AEROACOUSTIC ANALYSIS OF HOVERING ROTORS
Gennaretti, M., Rome Univ., Italy; Iemma, U., Rome Univ., Italy; Morino, L., Rome Univ., Italy; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 10 p; In English; See also 19960003572; Sponsored by Agusta Eli S.p.A.; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The subject of this paper is the unified aerodynamic and aeroacoustic analysis of transonic hovering rotors. The aerodynamic/aeroacoustic problem is stated in terms of the velocity potential, whereas the solution is determined by applying a shock-capturing boundary integral formulation. Particular emphasis is given to the analysis of the non-linear terms in the equation for the velocity potential, whose contribution cannot be neglected for the transonic flow case analysis. Their contribution is expressed in a conservative form. Starting from the solution for the potential, the Bernoulli theorem is used to determine both the pressure distribution on the body surface (aerodynamic solution) and the acoustic pressure in the field (aeroacoustic solution). Numerical results are presented in order to show the capability of the methodology in determining both the aerodynamic and aeroacoustic solutions for transonic rotor configurations.
Author
Aeroacoustics; Bernoulli Theorem; Boundary Integral Method; Dynamic Pressure; Helicopters; Hovering; Potential Flow; Pressure Distribution; Rotor Aerodynamics; Rotor Blades; Sound Pressure; Transonic Flow

19960003886 Technical Univ. of Munich, Muchen, Germany
SEPARATION OF LIFTING VEHICLES AT HYPERSONIC SPEED WIND TUNNEL TESTS AND FLIGHT DYNAMICS SIMULATION
Sachs, G., Technical Univ. of Munich, Germany; Schoder, W., Technical Univ. of Munich, Germany; Kraus, W., Deutsche Aerospace A.G., Germany; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 8 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Several topics of the separation maneuver of two-stage hypersonic vehicles are considered. Results which have been obtained from wind tunnel tests of the separation maneuver and related investigations on flight dynamics will be presented. In test facilities of DLR (Cologne), the aerodynamics characteristics of a two-stage space transportation system were investigated. The test campaign was focused on aerodynamic interference effects which exist when the two stages are in close proximity. The results of the wind tunnel tests provide a detailed data base for flight mechanics investigations. Numerical simulation of flight dynamics based on a well founded aerodynamics model is an appropriate technique to investigate such a highly dynamic maneuver. Control of both vehicles for achieving an optimal motion of the system is investigated. In addition, adequate stability and control characteristics from a piloting point of view are considered. Particular emphasis is put on a robust control technique. This is because robust control is an adequate means for dealing with

a system which shows great changes. During close proximity of the first and orbital stages, system changes are due to the separation maneuver itself because of aerodynamic interference effects.
Author
Aerodynamics; Flight Simulation; Hypersonic Speed; Hypersonic Vehicles; Lifting Bodies; Space Transportation System; Wind Tunnel Tests

19960020822 National Aerospace Lab., Amsterdam, Netherlands
WIND TUNNEL FLUTTER TESTING ON SHINGLES IN THE TRANSONIC AND SUPERSONIC SPEED REGIME
Persoon, Albert J., National Aerospace Lab., Netherlands; Nov. 1995; 16p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Various types of shingles, being part of the heat protection system of re-entry vehicles, were investigated in the transonic and supersonic speed regime using NLR's High Speed (HST) and Supersonic (SST) wind tunnels. The investigations were carried out in close cooperation with Marcel Dassault Aviations (AMD) and Daimler Benz Raumfahrt Infrastruktur GmbH (DASA-RI). A review is given of the wind tunnel experiments with emphasis on the generation and control of noise levels of the boundary layer in which the shingles were placed during the tests. The use of a spoiler or suction of the flow, both affecting the flutter characteristics of a shingle, will be discussed. The behavior of unsteady pressures close to the shingle (upstream and downstream) is highlighted as these pressures might act as a monitoring device to define the onset of flutter or limit cycle oscillations of a panel.
Author
Wind Tunnel Tests; Flutter; Transonic Speed; Supersonic Speed; Boundary Layers; Aeroacoustics; Noise Intensity; Sound Pressure; Thermal Protection; Reentry Shielding; Tiles

19960020827 NASA Langley Research Center, Hampton, VA United States
A QUARTER CENTURY OF NASA WIND-TUNNEL AND FLIGHT EXPERIMENTS INVOLVING AEROSERVOELASTICITY
Noll, Thomas E., NASA Langley Research Center, USA; Perry, Boyd, III, NASA Langley Research Center, USA; Perry, Boyd, III, NASA Dryden Flight Research Center, USA; Nov. 1995; 12p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Over the past quarter century, the NASA Langley Research Center (LaRC) and the NASA Dryden Flight Research Center (DFRC) have played major roles in the development, demonstration, and validation of aeroservoelastic modeling, analysis, design, and testing methods. Many of their contributions resulted from their participation in wind-tunnel and flight-test programs aimed at demonstrating advanced active control concepts that interact with and/or exploit the aeroelastic characteristics of flexible structures. Other contributions are a result of their interest in identifying and solving adverse aeroservoelastic interactions that allow unique flight-test demonstrations or flight envelope clearance programs to be successfully completed. This paper provides an overview of some of the more interesting aeroservoelastic investigations conducted in the transonic dynamics tunnel (TDT) at LaRC and in flight at DFRC. Four flight-test projects are reviewed in this paper. These test projects were selected because of their contributions to the state-of-the-art in active controls technology (ACT) or because of the knowledge gained in further understanding the complex mechanisms that cause adverse aeroservoelastic interactions.
Author
Aeroservoelasticity; Transonic Wind Tunnels; Wind Tunnel Tests; Flight Tests; Active Control

19960022344 Southampton Univ., Dept. of Aeronautics and Astronautics., United Kingdom
PRESSURE DRAG INDUCED BY A SUPERSONIC FLOW OVER CAVITIES
Zhang, Xin, Southampton Univ., UK; Feb. 1996; 10p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Pressure distribution and pressure drag due to a supersonic flow over a dual cavity geometry were studied at Mach 1.5 and 2.5. The study was performed numerically and results compared with an earlier experiment. The mass-averaged Navier-Stokes equations were solved using a finite-volume scheme. The inviscid cell interface fluxes were estimated using Roe's approximate Riemann solver with a second-order extension. Turbulence was modeled using a two-equation k-z model with compressibility corrections. Two test configurations were selected: (1) a length to depth ratio L/D = 1 cavity followed by another L/D = 1 cavity separated by a distance of 1D, and (2) an L/D = 3 cavity followed by an L/D = 1 cavity separated by a distance of 3D. The pressure and drag of the individual cavity was compared with those of a single cavity of same L/D. It was found that the pressure field around the L/D = 1 was substantially modified by a preceding L/D = 3 cavity.
Author
Pressure Drag; Supersonic Flow; Cavity Flow; Aerodynamic Configurations; Pressure Distribution

19960022345 Arnold Engineering Development Center, Micro Craft Technology., Arnold AFS, TN United States
COMPUTATIONAL APPROACH TO WEAPONS BAY FLOW FIELD AND CARRIAGE LOADS PREDICTIONS
Suhs, N. E., Arnold Engineering Development Center, USA; Feb. 1996; 12p; In English; See also 19960022326; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A computational capability has been developed for predicting the flow field in a three-dimensional weapons bay (or cavity). Computations have been performed for an empty bay and for a store placed within the weapons bay. The chimera overset grid methodology, a domain decomposition strategy, is used to simplify mesh generation. An implicit Navier-Stokes code with a thin-layer approximation is used to compute the weapons bay flow field at free-stream Mach numbers of 0.6, 0.95, and 1.20. The computational results are compared to experimental results for time-averaged pressure coefficients, overall sound pressure levels, and the frequency spectrum of the sound pressure levels on the bay walls. In addition, loads on a store placed within the bay are computed.
Author
Undercarriages; Flow Distribution; Cavity Flow; Three Dimensional Flow; Computational Grids; Prediction Analysis Techniques

19960029445 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
HYPERSONIC EXPERIMENTAL AND COMPUTATIONAL CAPABILITY, IMPROVEMENT AND VALIDATION, VOLUME 1 *L'HYPERSONIQUE EXPERIMENTALE ET DE CALCUL - CAPACITE, AMELIORATION ET VALIDATION*
Saric, William S., Editor, Arizona State Univ., USA; Muylaert, Jean, Editor, European Space Agency. European Space Research and Technology Center, ESTEC, Netherlands; Dujarric, Christian, Editor, European Space Agency, France; May 1996; 209p; In English
Report No.(s): AGARD-AR-319-Vol-1; ISBN 92-836-1037-7; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

The results of the phase 1 effort conducted under AGARD Working Group 18 on Hypersonic Experimental and Computational Capability, Improvement and Validation are presented in this report. A discussion of issues and problems classified into seven topic areas precedes the individual sections on Shock/Boundary-Layer Interactions, Laminar-Turbulent Transition, Rarefield Flow, Real-Gas Effects, Facility Calibration Procedures, Extrapolation to Flight and Hypersonic Test Facilities. Recommendations for future work in these areas is included at the end of each section. Conclusions for the work conducted during the phase 2 of this Working Group will be presented in Volume 2.
Author
Hypersonics; Shock Wave Interaction; Transition Flow; Boundary Layer Transition; Calibrating; Computational Fluid Dynamics; Test Facilities; Gas Dynamics; Research Facilities; Hypersonic Flow

19960053204 Glasgow Univ., Dept. of Aerospace Engineering, United Kingdom
PARALLEL IMPLICIT UPWIND METHODS FOR THE AERODYNAMICS OF AEROSPACE VEHICLES
Badcock, K. J., Glasgow Univ., UK; Richards, B. E., Glasgow Univ., UK; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167

Contract(s)/Grant(s): EPSRC/MOD-GR/H47371; DRA/MOD/BAeFRN1C/407; EPSRC-GR/K42264; NTI/65; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Research at the University of Glasgow, based around implicit methods for solving the Euler and Reynolds' averaged Navier-Stokes equations, has targeted advanced computational fluid dynamics (CFD) methods for tackling complex flow fields of interest to aerospace vehicle designers. The requirements for this application are for efficient, high resolution schemes which can be ported to various massively parallel processors (MPP) systems and implemented with a robustness to give fast turn around times at competitive costs. It is recognized that the most demanding topics concern unsteady viscous flows and thus time accuracy and efficiency is pursued as a high priority. This paper reviews the work, ongoing and planned, by the team at Glasgow in code developments embracing future computing environments and including some results not previously published. The example test cases used in the performance and sensitivity studies include transonic flow results on the RAE 2822 airfoil and ONERA M6 wing selected by AGARD. The computing environment to which the codes port include workstations, either used singly or clustered to provide a parallel computing domain, and also integrate distributed memory supercomputers such as CRAY T3D and Intel Hypercube systems. The paper outlines these technologies also.
Author

Computational Fluid Dynamics; Parallel Processing (Computers); Massively Parallel Processors; Navier-Stokes Equation; Unsteady Flow; Viscous Flow; Aerodynamic Loads; Upwind Schemes (Mathematics)

19970009248 Von Karman Inst. for Fluid Dynamics, Aeronautics/Aerospace Dept., Rhode-Saint-Genese, Belgium

HYPERSONIC AEROTHERMODYNAMICS AT VKI

Carbonaro, M., Von Karman Inst. for Fluid Dynamics, Belgium; Charbonnier, J.-M., Von Karman Inst. for Fluid Dynamics, Belgium; Deconinck, H., Von Karman Inst. for Fluid Dynamics, Belgium; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 58p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A04, Hardcopy; A04, Microfiche

The Aeronautics/Aerospace Department of the von Karman Institute has been involved in research activities in the hypersonic regime since the 1960's with the installation of the hypersonic free piston tunnel Longshot, which allows to simulate high Reynolds number hypersonic flows. Since then, a Mach 6 blow down facility H3 is also operational and at present time an induction heating facility called Plasmatron is being developed under supervision of the European Space Agency. Simultaneously to the development of experimental techniques, Computational Fluid Dynamics was initiated and in-house made codes are operational to simulate hypersonic flows without chemistry and in thermal equilibrium. The objective of the present paper is to briefly describe the research topics which have been addressed the past years and the current activities at the VKI in the hypersonic aerothermodynamics area. Basic research topics will be first presented and then applications to hypersonic vehicles and development of facilities will be discussed.
Author

Aerothermodynamics; Hypersonics; Research; Computational Fluid Dynamics; Wind Tunnel Tests; Hypersonic Flow

19970009249 Von Karman Inst. for Fluid Dynamics, CFD Group, Rhode-Saint-Genese, Belgium

A PARALLEL IMPLICIT MULTIDIMENSIONAL UPWIND CELL VERTEX NAVIER-STOKES SOLVER FOR HYPERSONIC APPLICATIONS

vanderWeide, E., Von Karman Inst. for Fluid Dynamics, Belgium; Issman, E., Von Karman Inst. for Fluid Dynamics, Belgium; Deconinck, H., Von Karman Inst. for Fluid Dynamics, Belgium; Gegrez, G., Von Karman Inst. for Fluid Dynamics, Belgium; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 12p; In English; See also 19970009247

Contract(s)/Grant(s): ESA-9363/91/NL/FG/CCN2; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A parallel perfect gas flow solver for axisymmetric applications is described. For the spatial discretization of the convective fluxes it uses a multidimensional upwind, monotonic shock capturing, matrix distribution scheme on a compact stencil (at most the points used by the Galerkin finite element discretization) in an unstructured grid, and the Galerkin finite element method for the viscous part. For fast convergence towards steady state a fully parallel implicit Newton algorithm has been implemented, where the resulting linear systems are solved by subdomain block ILV(0) preconditioned GMRES. A vertex-oriented domain decomposition is used allowing an efficient parallel preconditioner for the GMRES. As the linear systems themselves are solved on the complete grid, the convergence is practically independent of the way the grid is decomposed into subdomains. The message passing library MPI was used for the communication to make the code as portable as possible. Applications are shown for a hypersonic cone-fare configuration at different Mach and Reynolds numbers and a detailed comparison is made with a structured grid standard Finite Volume solver (the VKI-MB code). Results have been obtained on a four and eight processors SP2 demonstrating the robustness and efficiency of the new flow solver.
Author

Navier-Stokes Equation; Gas Flow; Upwind Schemes (Mathematics); Galerkin Method; Finite Element Method; Unstructured Grids (Mathematics); Computational Fluid Dynamics; Hypersonic Flow; Parallel Flow; Ideal Gas

19970009252 Cranfield Univ., Coll. of Aeronautics, Bedford, United Kingdom

HYPERSONIC LAMINAR-TURBULENT TRANSITION AND ITS IMPLICATIONS FOR WINGED CONFIGURATIONS

Poll, D. I. A., Cranfield Univ., UK; Oct. 1996; 24p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The problem of laminar-turbulent transition on swept back wings travelling at hypersonic speeds has a great practical significance. Swept back wings support three-dimensional boundary layer flows and, in consequence, two mechanisms for transition are admitted which do not occur in two-dimensional situations. These are attachment-line contamination and cross-flow instability. Both these are known to be very important in the generation of turbulent flow in low-speed flows. It is argued that these phenomena are also important in high speed conditions. Available evidence is reviewed and, when possible, estimates are made of the conditions necessary for the transition onset.
Author

Boundary Layer Transition; Hypersonic Flow; Swept Wings; Three Dimensional Boundary Layer; Reynolds Number; Boundary Layer Flow

19970009260 Daimler-Benz Aerospace A.G., Militarflugzeuge, Munich, Germany

THE TECHNOLOGY DEVELOPMENT AND VERIFICATION CONCEPT OF THE GERMAN HYPERSONICS TECHNOLOGY PROGRAMME

Hirschel, E. H., Daimler-Benz Aerospace A.G., Germany; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 18p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Within the German Hypersonics Technology Program, a Technology Development and Verification study was performed in order to structure the European Technology Maturation and Verification Phase. Elements of this study are discussed in this contribution. After an introduction to the topic, a classification of hypersonic vehicles is given and the general design process is sketched. The structure of the German Technology and Verification Study is shown, and the reference concept and the major flight parameters are presented. An assessment of aerothermodynamics simulation means ia given along with a consideration of some selected results of sensitivity studies and

an explanation of the Transfer Model approach, which was developed in the study. Some remarks on flight testing with experimental vehicles are followed by the summary of the results of the study.
Author
Hypersonics; Hypersonic Vehicles; Aerothermodynamics; Technology Assessment; Computerized Simulation

19970014096 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
THE CHARACTERISATION AND MODIFICATION OF WAKES FROM LIFTING VEHICLES IN FLUIDS *LA CARACTERISATION ET LA MODIFICATION DES SILLAGES CREES DANS LES FLUIDES PAR DES VEHICULES PORTANT*
The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 415p; In English; In French; Fluid Dynamics Panel, 20-23 May 1996, Trondheim, Norway; See also 19970014097 through 19970014132; Original contains color illustrations
Report No.(s): AGARD-CP-584; ISBN 92-836-0034-7; Copyright Waived; Avail: CASI; A18, Hardcopy; A04, Microfiche

Papers presented during the eight sessions addressed the following subjects: vortex wakes, air traffic control procedures, structure of a transport aircraft, the interaction between an injected vortex and a rolling up vortex sheet, three-dimensional turbulence models, and simulations of aircraft in vortex wakes.
Derived from text
Vortices; Wakes; Three Dimensional Models

19970014097 Technische Hogeschool, Dept. of Aerospace Engineering, Delft, Netherlands
VORTEX WAKES IN AERODYNAMICS
Hoeijmakers, H. W. M., Technische Hogeschool, Netherlands; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 12p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A survey is presented of the physics of vortex wakes as occur in the flow about aircraft configurations. The emphasis is on fundamental aspects of the flows and on the assessment of the mathematical models that can be used for numerically simulating vortex wakes.
Author
Wakes; Vortices; Flow Characteristics; Flow Geometry; Flow Measurement; Flow Visualization

19970014098 Boeing Commercial Airplane Co., Seattle, WA United States
WAKE VORTICES' EFFECTS AND THE NEED FOR PROMPT ACTION: A US VIEW
Mack, Gerald R., Boeing Commercial Airplane Co., USA; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 6p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The growth of commercial aviation has placed such demand on the air traffic system that many major U.S. airports are capacity limited and are experiencing significant traffic delays. These delays inconvenience passengers, cost the aviation industry hundreds of millions of dollars each year, and limit further growth of traffic. The existing wake turbulence separation distances represent a major challenge in ameliorating this congestion. to facilitate the introduction of the airplanes now categorized as 'heavy,' U.S. manufacturers worked with the Federal Aviation Administration (FAA) to conduct flight-test evaluations of the hazards of wake turbulence. These tests underscored, among other things, the necessity of three-dimensional flight path control. In light of the flight test findings, the FAA's effort focused on three areas: aircraft categories, air traffic control (ATC) procedures, and piloting procedures.
Author
Turbulence; Vortices; Wakes; Warning Systems; Airline Operations; Hazards

19970014101 Florida Atlantic Univ., Boca Raton, FL United States
THE INTERACTION BETWEEN AN INJECTED VORTEX AND A ROLLING UP VORTEX SHEET
Dhanak, M. R., Florida Atlantic Univ., USA; Vishwanthan, K. S., Florida Atlantic Univ., USA; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 6p; In English; See also 19970014096
Contract(s)/Grant(s): NSF BCS-92-11847; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The interaction between two symmetrically located finite Rankine vortices and an elliptically loaded vortex sheet is examined in the Treffetz plane for a range of flow parameters. The Rankine vortices, which are placed over the sheet, have vorticity of opposite sign to that of the adjacent section of the sheet. They may be considered to represent, in the Treffetz plane, vortices 'injected' into the flow from an upstream location. It is shown that there are in general three types of interactions which significantly affect the rolling up process. Accordingly, an interaction can result in straightforward merging, formation of subsidiary structures or considerable inboard displacement of the rolling up tip vortex. In the last case, the process should help to enhance the onset of the Crow instability considerably.
Author
Flow Characteristics; Vortex Sheets; Vortices

19970014102 University Coll., Aerospace Research Unit, Galway, Ireland
FLOWFIELD PREDICTION OF THREE-DIMENSIONAL WING TRAILING VORTICES USING ADVANCED TURBULENCE MODELS
Eaton, J. A., University Coll., Ireland; OFlaherty, M. P., University Coll., Ireland; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 8p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The feasibility of employing a general-purpose Navier-Stokes code, in conjunction with a reynolds stress transport turbulence model, for predicting wake vortex flow fields is investigated. Two test cases are considered, each employing two different turbulence models, a kappa-epsilon model, which is isotropic, and an anisotropic, differential Reynolds stress model. First the flow field around a low aspect ratio wing in a wind tunnel is computed to assess the influence of the surface and velocity distributions in the wake, particularly the streamwise component, are compared with measurements. Although the grids used are suboptimal, predictions indicate a qualitative improvement for the anisotropic model, in particular where the swirl component of the flow is greater, such as in the vortex core. Next, wind tunnel data are used as a starting point for an axisymmetric model of a free vortex with axial flow. These computations allow the effects of choice of turbulence model on the aging and decay of a vortex in the far field to be observed. The kappa-epsilon model predicts a rapid growth of the vortex, whereas the differential Reynolds stress model results in a more realistic, almost uniform evolution of the core radius.
Author
K-Epsilon Turbulence Model; Navier-Stokes Equation; Low Aspect Ratio Wings; Axial Flow; Reynolds Stress; Stress Analysis; Turbulence Effects; Vortices; Wakes

19970014103 Nielsen Engineering and Research, Inc., Mountain View, CA United States
AN UNSTEADY VORTEX WAKE MODEL FOR MANEUVERING VEHICLES
Mendenhall, M. R., Nielsen Engineering and Research, Inc., USA; Perkins, S. C., Jr., Nielsen Engineering and Research, Inc., USA; Nov. 1996; 12p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A preliminary-design and analysis capability applicable to vehicles in unsteady maneuvers involving nonlinear, time-dependent flow conditions is described. The approach is a direct coupling of fluid dynamics and flight mechanics for use in the flight regimes where the flow phenomena are dominated by vorticity and separation associated with high angles of attack and rapid motions. The modularized computer algorithm is based on mathematical flow models, supplemented by empirical information where necessary, which accurately represent the physics of complex flows. This physics-based method is applicable to generic configurations, and it is not dependent on specific empirical information, and it is economical to use. The resulting method can be used as a prediction capability for specified

vehicle motions or flow conditions, or it can be coupled with a six-degree-of freedom equation-of-motion solver to predict flight trajectories and transient performance characteristics.
Author
Turbulence Models; Fluid Dynamics; Equations of Motion; Degrees of Freedom; Angle of Attack; Vortices; Wakes; Fluid Flow

19970014104 Cambridge Univ., Engineering Dept., Cambridge, United Kingdom
EXPERIMENTAL ASSESSMENT OF THE EXTENDED BETZ METHOD FOR WAKE VORTEX PREDICTION
Graham, W. R., Cambridge Univ., UK; Nov. 1996; 12p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The extended Betz method, whereby wake vortex velocity predictions are obtained from a given wing lift distribution, is assessed by comparison with experimental results for wake cross-flow velocities behind a wing model with flaps. The required lift distributions are found from overall lift data and a lifting-line calculation, and the comparison is made for both clean and high-lift fundamental Betz assumption of effectively two-dimensional, inviscid flow in the wake is well supported, but that a proposed approximate invariant, the second moment of vorticity, is not conserved. In spite of this, the theoretical predictions for the single vortex shed by each half of the clean wing are found to be accurate. However, the multiple vortices arising from the wing in high-lift configuration are not as well predicted, and in this case the usefulness of the method seems to be restricted to providing estimates of the number of vortices, and their overall circulations.
Author
Wakes; Vortices; Predictions; Two Dimensional Flow; Inviscid Flow; Cross Flow; Aerodynamic Configurations

19970014105 Defence Research Agency, Electronics Sector, Malvern, United Kingdom
STRUCTURE, TRAJECTORY AND STRENGTH OF B747 AIRCRAFT WAKE VORTICES MEASURED BY LASER
Vaughan, J. M., Defence Research Agency, UK; Brown, D. W., Defence Research Agency, UK; Constant, G., Defence Research Agency, UK; Eacock, J. R., Defence Research Agency, UK; Foord, R., Defence Research Agency, UK; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 10p; In English; See also 19970014096; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Wake vortices of aircraft landing at Heathrow have been measured with a coherent laser radar. Analysis of the vortex velocity profiles from B747 aircraft shows a series of symmetrical dip or inversions on approach to the central core. Such inversion are not predicted theoretically and contrast with the uniformly increasing velocity profiles observed from other aircraft. Vortex trajectories may also be reconstructed; in one case a B747 vortex, after initial descent, returned to the glideslope with undiminished strength over a minute later.
Author
Wakes; Vortices; Aircraft Wakes; Velocity Distribution

19970014106 Federal Aviation Administration, Cambridge, MA United States
WAKE VORTEX DECAY NEAR THE GROUND UNDER CONDITIONS OF STRONG STRATIFICATION AND WIND SHEAR
Rudis, R. P., Federal Aviation Administration, USA; Burnham, D. C., Scientific and Engineering Solutions, Inc., USA; Janota, P., System Resources Corp., USA; Nov. 1996; 10p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Using the tower fly-by method, decay measurements were made on wake vortices generated by B-727, B-757 and B-767 aircraft. In addition to a 60-meter instrumented tower, two remote sensing systems were deployed: (1) Laser Doppler Velocimeter (LDV) (high resolution vortex profiles at ranges of 40-200 meters) and (2) Monostatic Acoustic Vortex Sensing System (MAVSS) (lower resolution profiles up to 500 meters beyond the tower location). Typical early morning meteorology during the test period consisted of stratified drainage flows. Because of the persistent crosswind, the MAVSS gave the most complete vortex decay information. Meteorological conditions were measured by instruments on the tower and on a tethersonde. The analysis looked for statistical relationships between vortex lifetime and several meteorological parameters, treated independently. Due to the meteorological conditions of stratification, low turbulence and wind shear, the upwind vortex lasted longer than the downwind vortex; the circulation remained above 140 m(exp)2/s for up to 125, 150 and 170 seconds for the B-727, B-757 and B-767, respectively. However, in every case, the crosswind was strong enough to sweep both wake vortices away from the generating location; in some cases the vortices traveled more than 500 meters laterally. Although these durations are much longer than the normally observed vortex lifetimes, they are related, according to the analysis, to strong crosswind shear coupled with low turbulence levels. While this long vortex migration at the observed strength levels might represent a potential vortex encounter hazard for operations on a downwind parallel runway, the drainage flow conditions which led to this unusual vortex behavior would be unlikely to occur at most airports.
Author
Wakes; Vortices; Parallel Flow; Wind Shear; Wind Direction; Runway Conditions; Hazards

19970014107 Boeing Commercial Airplane Co., Seattle, WA United States
WAKE TURBULENCE TRAINING AND REGULATION: AN INDUSTRY TEAM APPROACH
Carbaugh, David C., Boeing Commercial Airplane Co., USA; Forsythe, W. Douglas, Boeing Commercial Airplane Co., USA; Nov. 1996; 6p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes the development and content of the industry endorsed Wake Turbulence Training Aid and industry's input to regulators regarding wake turbulence efforts. The Wake Turbulence Training Aid is a safety document aimed at both pilots and air traffic controllers. The aid consists of a manual with pull out sections for easy use and a video of about 25 minutes in length. The reason for developing the aid is discussed. Increased traffic, mixed traffic, accidents and incidents, ASRS reports, and calls for action all culminated in needing training to step up to the need for more awareness and education for pilots and controllers. Who was involved in the development of the aid is discussed to highlight its international scope, as well as the time progression towards completion. The content of the aid is then discussed in detail. Lastly, the efforts of the industry team to make specific inputs to the FAA regarding efforts to reduce wake turbulence encounters and to improve safety is presented.
Author
Air Traffic Controllers (Personnel); Education; Wakes; Turbulence

19970014108 Federal Aviation Administration, Volpe National Transportation Systems Center, Cambridge, MA United States
GROUND-BASED ANEMOMETER MEASUREMENTS OF WAKE VORTICES FROM LANDING AIRCRAFT AT AIRPORTS
Abramson, S., Federal Aviation Administration, USA; Burnham, D. C., Scientific and Engineering Solutions, Inc., USA; Nov. 1996; 8p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In 1994 an array of two-axis propeller anemometers was installed at 10-meter height under the approach to Runway 31 R at Kennedy Airport. Since the aircraft are typically 50 meters above the ground at the test location, the wake vortices rapidly descend toward the ground where they are readily detected and measured by the anemometers. In 1995 a similar installation was made on Runway 27 at the Memphis Airport. The ultimate goal of this study is to better understand when wake vortices remain in the flight path of following aircraft. The data collection system operates automatically and hence provides wake vortex data under all weather conditions and at all times of day and night with minimal cost. Real-time remote display of the vortex locations was implemented. The anemometers are augmented with additional weather sensors to provide meteorological data with greater detail than the standard surface weather observations. New processing methods for the anemometer data were developed to determine vortex height and strength in addition to the lateral position that was traditionally obtained from ground-based anemometers. The anemometer array is particularly appropriate for studying the interaction of wake vortices with the ground. It readily detects the secondary vortices detached from the boundary layer by the influence of the

primary wake vortices; these secondary vortices produce the well known vortex bouncing. Such secondary vortices have not been seen by any other sensing system.
Author
Anemometers; Wakes; Vortices; Aircraft Landing; Wind Velocity Measurement; Flow Measurement; Flight Paths; Data Acquisition

19970014110 Technische Hogeschool, Low Speed Aerodynamics Lab., Delft, Netherlands
EXPERIMENTAL ANALYSIS OF THE VORTEX WAKE STRUCTURE BEHIND A PROPELLER-WING CONFIGURATION
Veldhuis, L. L. M., Technische Hogeschool, Netherlands; Rentema, D. W. E., Technische Hogeschool, Netherlands; Nov. 1996; 18p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A flow field survey was performed with a 5-hole pressure probe at 1 chord length behind a propeller-wing configuration revealing important qualitative and quantitative information on the propeller dominated interactive flow field. The model, that consists of a low aspect ratio semi-span wing model combined with a 4 bladed tractor propeller, was tested at several low subsonic flow conditions in the Delft University Low Speed Windtunnel. The distribution of total pressure and axial vorticity show, besides the well-known spiral tip vortex, a strong deformation of the slipstream structure. The deformation of the vortex wake is strongly related to the spanwise lift distribution of the propeller/wing configuration which might be used as a starting point for prediction of vortex formation and decay. It also determines the magnitude of the overall induced drag and the deformation process therefore has implications for the proper modelling of slipstreams used within theoretical prediction codes for the analysis of airplane performance. to obtain quantitative information from the field data the theory of Betz and Maskell was applied to determine the lift, the profile drag and the induced drag for both the model with and without running propeller. Comparison of these results with external balance measurements shows a good agreement. The lift distributions which were compared with surface pressure measurements reveal that a considerable amount of swirl is left in the slipstream after passage of the wing; an important observation for future optimisation of propeller-wing configurations. In general the flow field survey with traversing 5 hole probe appears to be a powerful technique to better understand propeller/wing interactive flows.
Author
Vortices; Flow Distribution; Low Aspect Ratio Wings; Wings; Wakes; Subsonic Flow; Slipstreams; Propellers

19970014111 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Design Aerodynamics, Brunswick, Germany
FLOWFIELD OF A WING EMBEDDED IN THE WAKE OF A BURSTED VORTEX
Longo, J. M. A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Orlowski, M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Strohmeyer, D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Nov. 1996; 8p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In the present paper the flowfield around a delta wing partially embedded in the wake of a bursted vortex is numerically studied at M(sub infinity)= 0.4. The simulation is carried out solving the Euler equations on two structured grids of about 2.3 million points and 300000 points respectively. Due to the lack of experimental results, special emphasis is put on the analysis of the effect of grid fineness on the wake-flow. The present investigation indicates that the spiraling flow of a vortex continues after breakdown with a swirl velocity comparable to that of a non-bursted vortex generated at lower angles of attack and hence interference effects coming from its wake persist long downstream.
Author
Angle of Attack; Delta Wings; Vortices; Wakes; Flow Distribution

19970014112 Boeing Commercial Airplane Co., Seattle, WA United States
STABILITY OF MULTIPLE TRAILING-VORTEX PAIRS
Crouch, J. D., Boeing Commercial Airplane Co., USA; Nov. 1996; 8p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The stability of two vortex pairs is analyzed as a model for the vortex system generated by an aircraft in flaps-down configuration. The co-rotating vortices on the starboard and port sides tumble about one another as they propagate downward. This results in a time-periodic basic state. The instabilities are periodic along the axes of the vortices with wavelengths that are large compared to the size of the vortex cores. The results show symmetric instabilities that are linked to the long-wavelength Crow instability. In addition, new symmetric and antisymmetric instabilities are observed at shorter wavelengths. These instabilities have growth rates 60-100% greater than the Crow instability. The system of two vortex pairs also exhibits transient growth which can lead to growth factors of 5 or 10 in one fourth of the time required for the same growth due to instability.
Author
Aircraft Wakes; Vortices; Blade-Vortex Interaction; Turbulent Mixing; Turbulent Flow; Vortex Generators

19970014113 NASA Ames Research Center, Moffett Field, CA United States
INITIATION OF THE CROW INSTABILITY BY ATMOSPHERIC TURBULENCE
Spalart, P. R., Boeing Commercial Airplane Co., USA; Wray, A. A., NASA Ames Research Center, USA; Nov. 1996; 8p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The interaction between vortex pairs and well developed isotropic turbulence is studied by Direct Numerical Simulation. It is a model of the effect of natural environmental disturbances on airplane wakes. The nondimensional turbulence intensity eta is in the range (0 .02, 0.5), typical of airplanes. The most amplified wavelength of the Crow instability is placed within the inertial range of the turbulence, which is typical in the atmosphere and fits the theoretical setting of Tombach and Crow & Bate. The vorticity peaks in cross-flow planes are tracked to reveal the deformation of the vortices. In agreement with visual observations, the Crow instability dominates in weak turbulence, whereas chaotic deformations are seen in stronger turbulence. The average wavelength is about 27% shorter than the most amplified one. The beginning of destruction is identified with the first changes in the connectivity of the lines; identifying the end of destruction is more elusive. The wake lifespans overlap those from flight tests, laboratory tests, and the theory of Crow & Bate. However, in strong turbulence, theory and simulation both predict shorter average lifespans than the tests do. The scatter in lifespans is almost as large in simulations as in flight tests; thus, the intermittency of turbulence appears to explain the scatter even without any other differences in conditions. We conclude that the predictability of wake destruction by this mechanism is very poor.
Author
Atmospheric Turbulence; Wakes; Vortices

19970014114 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
DIRECT NUMERIC SIMULATION OF SINUSOIDAL INSTABILITY
SIMULATION NUMERIQUE DIRECTE DE L'INSTABILITE SINUSOIDALE
Sipp, D., Office National d'Etudes et de Recherches Aerospatiales, France; Jacquin, L., Office National d'Etudes et de Recherches Aerospatiales, France; Sagaut, P., Office National d'Etudes et de Recherches Aerospatiales, France; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 10p; In French; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The results of sinusoidal instability which were developed in a vortical gate composed of two turbulent vapor trails are presented. The results are consistent with the theories of linear instability developed by Crow. The effects of the density of the airflow, the limiting conditions, and the shape of the initial perturbation on the quality of the solution are studied.
Author
Numerical Flow Visualization; Contrails

19970014115 Karlsruhe Univ., Inst. fur Stromungslehre und Stromungsmaschinen, Germany
STABILITY THEORY FOR TWO WINGTIP VORTICES BEHIND CRUISING AIRCRAFT
Ehret, Thorsten, Karlsruhe Univ., Germany; Nov. 1996; 10p; In

English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

To perform a stability analysis on an interesting flow field, an undisturbed quasi steady basic velocity profile of the concerned flow field must be provided. In case of wake vortices behind cruising aircraft, the velocity distribution within the vortices has to be evaluated as a function of the height coordinate z and the spanwise coordinate y. A three-dimensional vortex filament method was used to calculate the velocity field of the wake flow, because it is an efficient tool for flows consisting of large regions of vorticity. Vortex filament methods simulate such a flow field by discretizing the regions behind the aircraft wing which contain vorticity, and tracking this discretization in a Lagrangian reference frame. The velocity field behind the aircraft is determined kinematically from the given vorticity field and computed by an application of the Biot-Savart-law. Small perturbations are then superimposed on the given quasi steady base flow and this sum is then substituted into the governing equations. After a linearization process, two fourth order perturbation differential equations are found. They give rise to an eigenvalue problem with a complex eigenvalue S and eigenfunctions for the amplitudes of the disturbances.

Author

Aircraft Wakes; Stability Tests; Flight Tests; Base Flow

19970014120 National Aerospace Lab., Marknesse, Netherlands

FLOW FIELD SURVEY IN TRAILING VORTEX SYSTEM BEHIND A CIVIL AIRCRAFT MODEL AT HIGH LIFT

deBruin, Anton C., National Aerospace Lab., Netherlands; Hegen, Sinus H., National Aerospace Lab., Netherlands; Rohne, P. Bernd, National Aerospace Lab., Netherlands; Spalart, Philippe R., Boeing Commercial Airplane Co., USA; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 12p; In English; See also 19970014096; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The roll-up of the trailing vortex system behind a generic civil aircraft windtunnel model with extended flaps and slats is studied up to 5 wing spans downstream. A laser light sheet flow visualisation technique is used and detailed flow field measurements are made with a spanwise traversable rake with five-hole probes. The measurement results are compared against calculations with the 2D vorticity transport equation.

Author

Vorticity Equations; Aircraft Models; Civil Aviation; Vortices

19970014121 NASA Ames Research Center, Moffett Field, CA United States

MEASUREMENTS IN VORTEX WAKES SHED BY CONVENTIONAL AND MODIFIED SUBSONIC AIRCRAFT

Rossow, Vernon J., NASA Ames Research Center, USA; Nov. 1996; 10p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A theoretical and experimental program is underway at NASA Ames Research Center to first obtain a better understanding of the hazard posed by the vortex wakes of subsonic transports, and then to develop methods on how to modify the wake-generating aircraft in order to make the vortices less hazardous. This paper summarizes results obtained in the 80- by 120-Foot Wind Tunnel at NASA Ames Research Center on the characteristics of the vortex wakes that trail from 0.03 scale models of a B-747 and of a DC-10. Measurements are first described that were taken in the wakes with a hot-film anemometer probe, and with wings that range in size from 0.2 to 1.0 times the span of the wake generating models at downstream distances of 81 ft and 162 ft. behind the wake-generating model; i.e., at scale distances of 0.5 and 1.0 mile. The data are then used to evaluate the accuracy of a vortex-lattice method for prediction of the loads induced on following wings by vortex wakes.

Author

Vortex Lattice Method; Wakes; Vortices

19970014122 California Univ., Dept. of Mechanical Engineering, Berkeley, CA United States

NATURAL AND FORCED GROWTH CHARACTERISTICS OF THE VORTEX WAKE OF A RECTANGULAR AIRFOIL

Jacob, J. D., California Univ., USA; Liepmann, D., California Univ., USA; Savas, O., California Univ., USA; Nov. 1996; 12p; In English; See also 19970014096

Contract(s)/Grant(s): RTA-65V749; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The forced trailing vortex wake of a rectangular NACA 0012 airfoil with an aspect ratio of 8 is investigated experimentally. The experiments include limited five-hole probe measurements in the near wake in a wind tunnel and extensive DPIV measurements in the far wake in a town tank. Measurements are conducted on the natural wake and the forced wake at chord Reynolds numbers from 2 x 10(exp 4) to 6 x 10(exp 4). The wake is forced by axial jets located on each wing-tip injecting fluid into the vortex cores. The forcing is steady or pulsatile. Pulsatile forcing is varied from 1 Hz to 40 Hz and with the wing-tip jets in phase, out of phase, or one on/one off. Relevant parameters, including vortex separation, vorticity, circulation, and core size, are measured up to 1000 chord lengths behind the wing. Forcing increases both the separation of the vortex pair and the growth rate of the vortex core size. At low frequencies, these effects are monotonic with increasing forcing frequency. At high frequencies, the measurements suggest a complex response to forcing. Based on measurements and observations, some parameters of importance are suggested in exploring possible means of controlling the behavior of the vortex wake. The complexity of the problem dictates that any search for identifying practical solutions must be a concerted effort among experiments, analyses and numerics.

Author

Wakes; Vortices; Reynolds Number; Near Wakes; Aspect Ratio; Airfoils

19970014123 Centre Europeen Recherche et de Formation Advance en Calcul Scientific, CFD Project, Toulouse, France

THREE-DIMENSIONAL DIRECT NUMERICAL SIMULATIONS OF WAKE VORTICES: ATMOSPHERIC TURBULENCE EFFECTS AND REBOUND WITH CROSSWIND

Corjon, Alexandre, Centre Europeen Recherche et de Formation Advance en Calcul Scientific, France; Risso, Frederic, Centre Europeen Recherche et de Formation Advance en Calcul Scientific, France; Stoessel, Alain, Institut Francais du Petrole, France; Poinsot, Thierry, Centre Europeen Recherche et de Formation Advance en Calcul Scientific, France; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 22p; In English; See also 19970014096

Contract(s)/Grant(s): STNA/95/110; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents three-dimensional direct numerical simulations of a vortex pair. Two types of computations are conducted. The first type considers a vortex pair placed in an homogeneous turbulent field. The phenomenon of interaction between the vortices and the turbulence is analyzed in details from two simulations calculated on a 135(exp 3) nodes mesh grid (one case with axial core velocity, the other without). The results show that the role of large and small turbulent eddies can be separated into two fairly independent mechanisms. The large structures are stretched by velocity gradients induced by the vortex pair. That leads to the formation of both tubes of vorticity spinning azimuthally around each vortex and associated axial velocity sheets. These turbulent structures cause a strong decrease of the maximal velocity and curvature of the vortices. These deformations of the vortex induced by the turbulence initiate an antisymmetric long-wave instability of the pair which will probably lead to the collapse of the vortices. Concurrently, the small structures can enhance the diffusion of the vorticity out of the vortex core. From this analysis and dimension considerations, the correct form for a model of decay of the vortices is derived. On the other hand, nine simulations on a 813 nodes mesh grid are used to determine the sensibility of the results upon the random turbulent initial conditions. The second type of computations considers a vortex pair placed in a laminar flow field near the ground. This laminar flow is representative of a neutral surface boundary layer. The effect of variable crosswind shear is studied with the effect of an axial wind. A comparison between the two-dimensional and the three-

dimensional results shows that the main phenomenom is not modified but that the altitude of rebound depends on the three components of the wind.
Author
Atmospheric Boundary Layer; Atmospheric Turbulence; Laminar Flow; Three Dimensional Models; Turbulence Effects; Turbulent Flow; Vortices; Wakes

19970014124 Institut de Mechanique de Grenoble, Div. Mechanique du Vol, Saint-Martin d'Heres, France
CHARACTERISATION AND MODELLING OF AIRCRAFT WAKE BASED ON TESTS OF SCALED MODELS IN A LABORATORY *CARACTERISATION ET MODELISATION DU SILLAGE D'UN AVION A PARTIR D'ESSAIS EN VOL DE MAQUETTES EN LABORATOIRE*
Cotton, Patricia, Institut de Mechanique de Grenoble, France; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 12p; In French; See also 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The fluid Mechanics Institute of Lille (IMFL), off-site center of ONERA, has developed for many years specific experimental methods based on flight tests of scaled models performed in a laboratory. These methods are here applied to the characterization with a view to modelling of transport aircraft wake.
Author
Aircraft Wakes; Transport Aircraft

19970014125 Stanford Univ., Dept. of Aeronautics and Astronautics, Stanford, CA United States
DIRECT NUMERICAL SIMULATION OF THE BREAKDOWN OF AIRCRAFT WAKE VORTICES
Rennich, S. C., Stanford Univ., USA; Lele, S. K., Stanford Univ., USA; Nov. 1996; 10p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

An investigation is initiated that aims to improve the understanding of how disturbances to aircraft vortex wakes, applied at the wing, survive the roll-up process and eventually lead to destruction, or 'breakdown', of the wake. To efficiently perform this investigation, a numerical method is presented which accurately and efficiently computes flows in domains that are unbounded in two directions and periodic in the third, subject to the condition that vorticity is compactly distributed in the unbounded directions. This new code is used to compute the growth of symmetric disturbances on a pair of counter rotating columnar vortices. For high Reynolds number, the inviscid, linear vortex filament results of Crow (5) which predict the most unstable wavelength and its amplification rate, are reproduced well. From these computations an eigenfunction of the Crow instability as it exists in an evolving viscous vortex pair is extracted. The evolution of a perturbed plane wake due to an elliptically loaded wing is computed. It is observed that a perturbation of the correct wavelength rapidly evolves into the Crow instability and grows at approximately the predicted rate.
Author
Aircraft Wakes; High Reynolds Number; Inviscid Flow; Vortex Filaments; Vortices; Wakes

19970014126 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. for Fluid Mechanics, Goettingen, Germany
THE INVISCID MOTION OF A VORTEX PAIR IN A COMPRESSIBLE AND STRATIFIED ATMOSPHERE
Stuff, Roland, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Nov. 1996; 10p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The movement of an inviscid vortex pair in a compressible atmosphere including buoyancy effects is described by analytic solutions. The effects of compressibility are dealt with in an isentropic atmosphere. The work of compression done by the atmosphere on the vortex is entirely consumed by the isentropic change of the thermodynamic state of the vortex pair. The acceleration of the accompanying and apparent mass is given by the displacement of the two vortices towards each other. The effects of buoyancy are investigated by means of a two-dimensional, incompressible, inviscid vortex pair which is heavier than the ambient fluid. It turns out that the condition of pressure continuity across the separating streamline can be achieved only by assuming an increase in circulation of the two vortices.The mass accompanying the vortex pair under the effect of nonconservative forces converts a fraction of its gravity potential into an increase of stagnation pressure. Both, the analytical formulas for compressibility and buoyancy, then, are combined to describe both effects simultaneously. Thus, inconsistencies of other papers are eliminated.
Author
Vortices; Inviscid Flow; Buoyancy

19970014127 Technische Hochschule, Dept. of Aerospace Engineering, Aachen, Germany
EXPERIMENTAL AND NUMERICAL RESULTS ON SPIRAL VORTEX BREAKDOWN
Backstein, Sven H., Technische Hochschule, Germany; Nov. 1996; 8p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Experiments and numerical simulations have been performed to investigate the spiral breakdown of a wing tip vortex in flowfields of adverse axial pressure gradient. The basic idea was to stretch the transition domain between A and B by a reduction of the imposed pressure gradient. Embedding the vortex in a flowfield with only gradual axial retardation, a stretching could be achieved in both, experiment and calculation, giving some interesting insight into the mechanism of vortex breakdown. The appearance of reversed axial flow, upstream of the spiral, is identified as the distinctive feature of vortex breakdown, that must lead to the loss of axial symmetry and to an unsteady flow.
Author
Axial Flow; Flow Distribution; Reversed Flow; Unsteady Flow; Vortex Breakdown; Wing Tip Vortices

19970014128 Naval Postgraduate School, Dept. of Aeronautics and Astronautics, Monterey, CA United States
COMPUTATIONAL AND EXPERIMENTAL INVESTIGATION OF THE WAKES SHED FROM FLAPPING AIRFOILS AND THEIR WAKE INTERFERENCE/IMPINGEMENT CHARACTERISTICS
Dohring, C. M., Naval Postgraduate School, USA; Platzer, M. F., Naval Postgraduate School, USA; Jones, K. D., Naval Postgraduate School, USA; Tuncer, I. H., Naval Postgraduate School, USA; Nov. 1996; 10p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Computational and experimental water tunnel investigations of the wakes shed from flapping airfoils are described. It is shown that there exists a critical nondimensional plunge velocity above which the wake changes from a symmetric thrust-producing vortical structure to an asymmetric lift and thrust-producing one. Furthermore, it is found that the impingement of the wake generated by a flapping airfoil on a stationary airfoil produces a significant thrust augmentation on the flapping/stationary airfoil combination. Similarly, there exists a beneficial ground interference effect if the airfoil is flapping near a stationary wall. The experimental data are based on flow visualization using a two-color dye injection technique and laser-doppler velocimetry. The numerical results are obtained from an unsteady inviscid incompressible two-dimensional panel code and from a two-dimensional Navier-Stokes code. Comparisons between the experimental and numerical results show good agreement.
Author
Aerodynamic Interference; Airfoils; Flow Visualization; Dye Lasers; Inviscid Flow; Navier-Stokes Equation; Panel Method (Fluid Dynamics); Wakes

19970014129 NASA Langley Research Center, Hampton, VA United States
RECENT LABORATORY AND NUMERICAL TRAILING VORTEX STUDIES
Delisi, Donald P., Northwest Research Associates, Inc., USA; Greene, George C., NASA Langley Research Center, USA; Robins, Robert E., Northwest Research Associates, Inc., USA; Singh, Raminder, Indian Inst. of Tech., India; Nov. 1996; 10p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Results from two laboratory studies and two numerical studies are presented. In the first laboratory study, measurements of the strength of vortices from a three-dimensional (3-D) model wing are presented. The measurements follow the vortices as they evolve in time from a two-dimensional (2-D) line vortex pair to the development and migration of 3-D vortex rings. It is shown that the resulting vortex rings can contain up to 40 percent of the initial vortex circulation. Thus, the formation of vortex rings may not necessarily signal the end of the

wake hazard to following aircraft. In the second laboratory study, we present the results of an experiment which shows how the spanwise drag distribution affects wake-vortex evolution. In this experiment, we modified the spanwise drag distribution on a model wing while keeping the total lift and drag constant. The results show that adding drag on or near the centerline of the wing has a larger effect than adding drag at or near the wingtips. These measurements complement the results of NASA studies in the 1970s. In the first numerical study, results of 3-D numerical calculations are presented which show that the vortex Reynolds number has a significant influence on the evolution and migration of wake vortices. When the Reynolds number is large, 3-D vortex rings evolve from the initially 2-D line vortex pairs. These vortex rings then migrate vertically. When the Reynolds number is lower, the transition of vorticity from 2-D to 3-D is delayed. When the Reynolds number is very low, the vortices never transition to 3-D, and the vertical migration is significantly reduced. It is suggested that this effect may have been important in previous laboratory wake-evolution studies. A second numerical study shows the influence that vertical wind shear can have on trailing vortex evolution.
Author
Wakes; Wind Shear; Wings

19970014130 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fur Physik der Atmosphare, Bonn, Germany
WAKE DYNAMICS AND EXHAUST DISTRIBUTION BEHIND CRUISING AIRCRAFT
Gerz, Thomas, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Ehret, Thorsten, Karlsruhe Univ., Germany; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 12p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

By means of a vortex-filament technique and large eddy simulations dynamics are discussed which control the distribution of the exhaust of a subsonic aircraft under cruising conditions from the nozzle exit to the distance where the trailing vortex pair starts to collapse into turbulence. Emphasis is first put on the method; second on the initial roll-up process and the phenomenon of 'non-entrainment' of exhaust into the vortex cores. Third, the role of turbulence on the onset of the wingtip-vortex decay is considered; thereby it is distinguished between background atmospheric turbulence and turbulence steming from the boundary-layer around the aircraft.
Author
Aircraft Wakes; Wing Tips; Turbulence Effects; Vortex Filaments

19970018630 Wright Lab., Weapon Flight Mechanics Div., Eglin AFB, FL United States
ANALYSIS OF WRAP-AROUND FIN AND ALTERNATIVE DEPLOYABLE FIN SYSTEMS FOR MISSILES
Abate, Gregg L., Wright Lab., USA; Winchenbach, Gerald, Wright Lab., USA; Nov. 1996; 12p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper will present aerodynamic results of investigations of wrap around fin missile configurations. The investigations were carried out at Wright Laboratory's Armament Directorate, Eglin AFB, FL. The investigations have shown that instabilities exist in the form of an undamped side moment induced by the pitching motion of the missile, a roll moment at zero degrees angle-of-attack, and a roll moment reversal through Mach 1. This paper will also present data for alternative deployable fin designs.
Author
Missile Configurations; Fins; Wrap; Aerodynamic Coefficients; Computational Fluid Dynamics

19970018632 MATRA Defense Espace, Velizy-Villacoublay, France
PRACTICAL USE OF FLIGHT TESTS RESULTS FOR ESTIMATIONS OF AERODYNAMIC COEFFICIENTS *DETERMINATION DE COEFFICIENTS AERODYNAMIQUES AVEC DES RESULTATS D'ESSAIS EN VOL*
Schmitt, G., MATRA Defense Espace, France; Nov. 1996; 15p; In French; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

At the end of a missile development, flight tests have to validate the overall missile performances. The flight tests are particularly used for the validation of the aerodynamic characteristics. After that, some improvements of the aerodynamic modeling or even adjustments of the aerodynamic design can be initiated. Simulations allow to limit expensive flight tests to a minimal number needed to perfect the guidance and control functions embedded in the missile. The aerodynamic coefficients are not directly measured in flight, but computed from measured flight data. Some results obtained with a long range cruise missile are therefore presented. The comparison with wind tunnel test data are explained and are satisfactory.
Author
Cruise Missiles; Aerodynamic Coefficients

19970018635 Roketsan A.S. Ankara, Turkey
MONTE CARLO SIMULATION STUDIES OF UNGUIDED AND GUIDED MISSILES BASED ON PROBABILISTIC MODELLING OF AERODYNAMIC COEFFICIENTS
Merttopcuoglu, A. Osman, Roketsan A.S. Ankara, Turkey; Ozdamar, Hudai H., Roketsan A.S. Ankara, Turkey; Ozgoren, M. Kemal, Middle East Technical Univ., Turkey; Nov. 1996; 8p; In English; See also 19970018626
Contract(s)/Grant(s): AGARD Proj. T77; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The main motivation underlying this work is to develop a methodology by which the effect of aerodynamic estimation errors on flight simulation problems are investigated. A 'family' is defined as a predetermined class of similar missile configurations for which a reference aerodynamic data is available. The error is defined as the difference between the results of the 'available computational method' and the reference data. Then the statistical characteristics of the errors in the aerodynamic coefficients are determined assuming Gaussian probability distribution for the members of the 'family'. For a proposed missile configuration which fits to the 'family', the aerodynamic coefficients are first obtained using the 'available computational method'. Afterwards, the errors in these aerodynamic coefficients are estimated using the statistical characteristics determined above.
Derived from text
Monte Carlo Method; Guidance (Motion); Aerodynamic Coefficients; Flight Simulation

19970018638 Technical Univ. of Lisbon, Mechanical Engineering Dept., Portugal
AERODYNAMICS OF THE ARMOR X7 UAV
deBrederode, V., Technical Univ. of Lisbon, Portugal; Jorge, P. A., Technical Univ. of Lisbon, Portugal; Marcelino, J. R., Technical Univ. of Lisbon, Portugal; Patraquim, R., Technical Univ. of Lisbon, Portugal; Nov. 1996; 11p; In English; See also 19970018626; Sponsored in part by PEDIP; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The paper reports the most significant aspects of the aerodynamic design and testing of a low speed UAV which is being developed in Portugal as a joint University/Industry project. Starting from a baseline configuration of the air-vehicle aimed at complying with mission requirements in terms of endurance and range, a parametric sensitivity study is carried out for defining the optimum lay-out of the liftinG surfaces. The family of the wing aerofoils is selected from the Wortmann series and a new aerofoil is designed for the tip section. Predicted and wind-tunnel results for the fuselage and inner-wing panels are reported and discussed and an assessment of the aerodynamic behaviour of the whole configuration is made.
Derived from text
Aerodynamic Characteristics; Design Analysis; Flight Tests; Airfoils; Armor; Pilotless Aircraft

19970026365 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
CAPSULE AEROTHERMODYNAMICS *L'AEROTHERMODYNAMIQUE DES CAPSULES*
Capsule Aerothermodynamics; May 1995; 296p; In English, 20-22 Mar. 1995, Rhode-Saint-Genese, Belgium; See also 19970026366 through 19970026379
Report No.(s): AGARD-R-808; ISBN 92-836-1053-9; Copyright Waived; Avail: CASI; A13, Hardcopy; A03, Microfiche

Lecture notes for the AGARD Fluid Dynamics Panel (FDP) Special Course on 'Capsule Aerothermodynamics' have been assembled in this report. Aerodynamic design aspects related to planetary probe and capsule configurations are covered, as well as critical phenomena occurring during the different regimes of flight. The impact of real gas and rarefaction on capsule aerothermodynamics, and in particular on forebody and wake flow, is addressed. The material

assembled in this report was prepared under the combined sponsorship of the AGARD Fluid Dynamics Panel, the Consultant and Exchange Program of AGARD, and the von Karman Institute (VKI) for Fluid Dynamics.
Author
Aerothermodynamics; Heat Transfer; Space Probes; Hypersonic Flow; Space Capsules; Aerodynamics; Lectures; Rarefied Gas Dynamics; Rarefaction

19970026366 European Space Agency. European Space Research and Technology Center, ESTEC, Aerothermodynamic Section, Noordwijk, Netherlands
CAPSULE AEROTHERMODYNAMICS: MISSIONS, CRITICAL ISSUES OVERVIEW AND COURSE ROADMAP
Muylaert, Jean, European Space Agency. European Space Research and Technology Center, ESTEC, Netherlands; Capsule Aerothermodynamics; May 1995; 24p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

At present, on a world scale, different capsules and penetrators are being considered for planetary entry such as the Huygens probe to Titan, the Intermarsnet to Mars, and the Mercury orbiter probe to Venus. In addition conceptual studies for earth reentry are in progress for crew transport vehicles. Their geometries vary from low lift to drag ratio Apollo type to more advanced and complex bent biconic high lift to drag configurations. Because of the renewed interest in Capsule Aerothermodynamics, this course is organized to stimulate research in this field for young engineers as well as to update expertise for more experienced aerodynamicists. The course will cover all aerodynamic design aspects related to planetary probe and capsule configurations. Critical phenomena occurring during the different regimes of flight from the rarefied through the hypersonic, supersonic, transonic and subsonic portions of flight will be reviewed. The impact of real gas and rarefaction on capsule aerothermodynamics and in particular on forebody and wake flows will be addressed. In addition present day computational and experimental capabilities to assess radiation, blackout, ablation and the characterization of the dynamic derivatives will be discussed.
Author
Aerodynamic Configurations; Aerothermodynamics; Hypersonics; Real Gases; Rarefaction; Space Capsules; Interplanetary Spacecraft; Forebodies; Aerodynamics; Spacecraft Design

19970026370 NASA Langley Research Center, Hampton, VA United States
RAREFIED FLOWS OF PLANETARY ENTRY CAPSULES
Moss, James N., NASA Langley Research Center, USA; May 1995; 34p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The impact of rarefaction on entry capsules and spacecraft aerothermodynamics is emphasized for various aeroassist missions. The capability of the direct simulation Monte Carlo (DSMC) method to simulate such flows is demonstrated through examples of validation studies and applications. Several space flight projects and ground-based experiments are reviewed for which rarefaction effects have significant effect on spacecraft performance or experimental measurements. This review clearly demonstrates the significant role that the DSMC method plays in characterizing such flows.
Author
Computerized Simulation; Computational Fluid Dynamics; Atmospheric Entry; Monte Carlo Method; Aerothermodynamics; Aeroassist; Rarefied Gas Dynamics; Space Capsules; Hypersonic Flow; Rarefaction; Interplanetary Spacecraft

19970026371 NASA Ames Research Center, Moffett Field, CA United States
REAL GAS: CFD PREDICTION METHODOLOGY FLOW PHYSICS FOR ENTRY CAPSULE MISSION SCENARIOS
Deiwert, George S., NASA Ames Research Center, USA; May 1995; 10p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Mission and concept studies for space exploration are described for the purpose of identifying flow physics for entry capsule mission scenarios. These studies are a necessary precursor to the development and application of CFD prediction methodology for capsule aerothermodynamics. The scope of missions considered includes manned and unmanned cislunar missions, missions to the minor planets, and missions to the major planets and other celestial objects in the solar system.
Author
Aerothermodynamics; Real Gases; Computational Fluid Dynamics; Space Capsules; Space Exploration; Prediction Analysis Techniques; Atmospheric Entry; Interplanetary Spacecraft; Spacecraft Design; Interplanetary Flight

19970026372 NASA Ames Research Center, Moffett Field, CA United States
DATA BASE FOR CFD VALIDATION
Deiwert, George S., NASA Ames Research Center, USA; May 1995; 16p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The flow behind the shock wave formed around objects which fly at hypervelocity behaves differently from that of a perfect gas. Molecules become vibrationally excited, dissociated, and ionized. The hot gas may emit or absorb radiation. When the atoms produced by dissociation reach the wall surface, chemical reactions, including recombination, may occur. The thermochemical phenomena of vibration, dissociation, ionization, surface chemical reaction, and radiation are referred to commonly as high-temperature real-gas phenomena. The phenomena cause changes in the dynamic behavior of the flow and the surface pressure and heat transfer distribution around the object. The character of a real gas is described by the internal degrees of freedom and state of constituent molecules; nitrogen and oxygen for air. The internal energy states, rotation, vibration and electronic, of the molecules are excited and, in the limit, the molecular bonds are exceeded and the gas dissociated into atomic and, possibly, ionic constituents. The process of energy transfer causing excitation, dissociation and recombination is a rate process controlled by particle collisions. Binary, two-body, collisions are sufficient to cause internal excitation, dissociation and ionization while three-body collisions are required to recombine the particles into molecular constituents. If the rates of energy transfer are fast with respect to the local fluid dynamic time scale the gas is in, or nearly in, equilibrium. If the energy transfer rates are very slow the gas can be described as frozen. In all other instances, wherein any of the energy exchange rates are comparable to the local fluid time scale, the gas will be thermally or chemically reacting and out of equilibrium. Real gas thermochemical nonequilibrium processes are important in the determination of aerodynamic heating; both convective (including wall catalytic effects) and radiative heating. to illustrate this we consider the hypervelocity flow over a bluff body typical of an atmospheric entry vehicle or an aerospace transfer vehicle (ASTV). The qualitative aspects of a hypersonic flow field over a bluff body are discussed in two parts, forebody and afterbody, with attention to which particular physical effects must be included in an analysis. This will indicate what type of numerical modeling will be adequate in each region of the flow. A bluff forebody flow field is dominated by the presence of the strong bow shock wave and the consequent heating, and chemical reaction of the gas. At high altitude hypersonic flight conditions the thermal excitation and chemical reaction of the gas occur slowly enough that a significant portion of the flow field is in a state of thermochemical nonequilibrium. A second important effect is the presence of the thick boundary layer along the forebody surface. In this region there are large thermal and chemical species gradients due to the interaction of the gas with the wall. Also at high altitudes the shock wave and the boundary layer may become so thick that they merge; in this case the entire shock layer is dominated by viscous effects.
Author
Aerodynamic Heating; Aerospace Vehicles; Afterbodies; Atmospheric Entry; Bluff Bodies; Data Bases; Energy Transfer; Flight Conditions; Forebodies; Heat Transfer; High Temperature Gases; Hypersonic Flight; Internal Energy; Shock Waves; Computational Fluid Dynamics

19970026373 Aerospatiale, Dept. Aerodynamique and Electromagnetisme, Les Mureaux, France
BLUNT BODIES DYNAMIC DERIVATIVES
Baillion, M., Aerospatiale, France; May 1995; 28p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This document addresses the aerodynamic damping coefficients of capsules and planetary entry probes. First, the general item of dynamic coefficients will be described, and the specificity of large drag,

blunted shapes will be described. A tentative description of the dynamic instability of the capsule type shapes will be shown. This dynamic instability has strong consequences at system level, in the frame of the development phase of both capsules and planetary entry probes, which will then be depicted. The determination of the dynamic coefficients will be addressed, both by theoretical and experimental ways. Finally, the HUYGENS entry module case will be detailed.
Author
Atmospheric Entry; Space Capsules; Space Probes; Blunt Bodies; Aerodynamic Coefficients; Dynamic Stability; Oscillation Dampers; Hypersonic Wakes; Uncontrolled Reentry (Spacecraft); Dynamic Control

19970026374 Aerospatiale, Dept. Aerodynamique and Electromagnetisme, Les Mureaux, France
RADIATIVE HEAT FLUX: THEORETICAL AND EXPERIMENTAL PREDICTIONS FOR TITAN ENTRY PROBE
Baillion, M., Aerospatiale, France; Taquin, G., Aerospatiale, France; May 1995; 30p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This document presents the rationale of radiative heat flux predictions which were performed in the frame of the HUYGENS probe project. Due to the particular nature of TITAN atmosphere. associated to the entry velocity of the probe, the radiative heat flux is almost half of the total heat flux. In the thermal protection design process, accurate radiative heat flux calculations are needed in order to design a secured environment for onboard experiments, while mass penalties of thermal protection must be avoided. This document describes the theoretical and experimental investigations of the radiative heat fluxes which were performed in the frame of the HUYGENS program.
Author
Huygens Probe; Titan; Heat Flux; Aerodynamic Heating; Aerothermodynamics; Radiative Heat Transfer; Hypersonic Flow; Forebodies; Shock Layers; Atmospheric Entry; Thermal Protection

19970026379 Aerospatiale, Dept. Aerodynamique and Electromagnetisme, Les Mureaux, France
AEROTHERMODYNAMIC REQUIREMENTS AND DESIGN OF THE HUYGENS PROBE
Baillion, M., Aerospatiale, France; May 1995; 28p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper presents the relationship between the main system requirements of the HUYGENS probe, derived either from mission analysis or from experiment related requirements, to the aerodynamics and aerothermodynamics studies. The first part of the document will present the main mission and experiment related requirements, as they are expressed at the very beginning of the project, and which are derived from the specificity of the mission, without any direct link with aerothermodynamics. The general system requirements of the HUYGENS probe, are the ones which are expressed by the customer ESA towards the industrial prime contractor Aerospatiale Space & Defense, and which correspond to the elementary requirements of feasibility of the mission, in terms of general objective: reach TITAN, survive a 7 years cruise in deep space, survive to the hypersonic entry in TITAN atmosphere. The second part will show how these very general requirements are translated in terms of aerothermodynamics requirements. The third part will show how these aerothermodynamics requirements are implemented in general aerothermodynamics studies and test plan, which has been actually performed in the frame of the HUYGENS project. The choice of the shapes, the Computational Fluid Dynamics (CFD) and test plan, the related CFD and wind tunnel specificity and difficulties are addressed. The need for characterisation of the convective and radiative heat fluxes in an unknown environment is shown. Finally very specific items like contamination and spin device are addressed.
Author
Aerothermodynamics; Convective Heat Transfer; Huygens Probe; Hypersonics; Computational Fluid Dynamics; Aerodynamics; Aerodynamic Heating; Hypersonic Reentry

19980018682 Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese, Belgium
EXTERNAL HYPERSONIC AERODYNAMICS: STATE-OF-THE-ART AND FUTURE PERSPECTIVE
Wendt, John F., Von Karman Inst. for Fluid Dynamics, Belgium; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 8p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

An overview is provided on the activities, conclusions and recommendations of AGARD Working Group 18. Four issues were defined and addressed; shock wave boundary layer interactions, transition, real-gas effects, and rarefied-flow effects. Three status reports were prepared on calibration procedures for high-enthalpy facilities, extrapolation of wind tunnel results to flight, and real-gas facilities. While considerable progress has been made in our understanding of external hypersonic flows through experiments in new facilities, advances in CFD, and improved modelling of complex phenomena, more efforts must be devoted to this area if the risks of failure or overdesign are to be reduced to acceptable levels. Specifically, resources should be allocated to: u resolve facility, computational, and modelling deficiencies u accelerate the multiple facility/multiple computation strategy with standard models employed by Working Group 18.
Derived from text
Hypersonic Flow; Aerodynamics; Boundary Layer Transition; Shock Wave Interaction; Rarefied Gas Dynamics; Real Gases; Extrapolation

19980018684 Calspan-Buffalo Univ. Research Center, NY United States
AEROTHERMAL CHARACTERISTICS OF SHOCK/SHOCK INTERACTION REGIONS IN HYPERSONIC FLOWS
Holden, Michael S., Calspan-Buffalo Univ. Research Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 14p; In English; See also 19980018672
Contract(s)/Grant(s): SDIO84-93-C-0001; F49620-95-1-0292; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A review is presented of the aerothermal characteristics of regions of shock/shock interaction in hypersonic flow. Here, we discuss four aspects of the problem: (1) the requirements for accurate measurements in these flows; (2) the characteristics of shock/shock interaction regions in rarefied and laminar flows; (3) the aerothermal loads generated in transitional regions of shock/shock interaction; and (4) real-gas effects in regions of shock/shock interaction. The characteristics of shock/shock interaction regions and the influence of Mach number and Reynolds number on the heating loads developed in them are discussed. Correlations are presented together with the results of semi-empirical prediction methods to describe the aerothermal loads spanning the non-continuum to high Reynolds number flow regime. Some preliminary results are presented to demonstrate that the real-gas effects act to diffuse and lower the aerothermal loads relative to the ideal gas environment.
Derived from text
Aerothermodynamics; Shock Wave Interaction; Hypersonic Flow; Laminar Flow; Rarefied Gas Dynamics; Real Gases

19980018685 NASA Langley Research Center, Hampton, VA United States
ADVANCES IN COMPUTATIONAL CAPABILITIES FOR HYPERSONIC FLOWS
Kumar, Ajay, NASA Langley Research Center, USA; Gnoffo, Peter A., NASA Langley Research Center, USA; Moss, James N., NASA Langley Research Center, USA; Drummond, J. Philip, NASA Langley Research Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 14p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The paper reviews the growth and advances in computational capabilities for hypersonic applications over the period from the mid-1980's to the present day. The current status of the code development issues such as surface and field grid generation, algorithms, physical and chemical modeling, and validation is provided. A brief description of some of the major codes being used at NASA Langley Research Center for hypersonic continuum and rarefied flows is provided, along with their capabilities and deficiencies. A number of

application examples are presented, and future areas of research to enhance accuracy, reliability, efficiency, and robustness of computational codes are discussed.
Derived from text
Hypersonic Flow; Computer Programs; Grid Generation (Mathematics); Algorithms; Computer Systems Performance

19980018686 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Stroemungsmechanik, Goettingen, Germany
COMPUTATIONAL SIMULATION OF HYPERSONIC EXTERNAL FLOW: STATUS OF CFD IN EUROPE
Kordulla, W., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Morice, Ph., Office National d'Etudes et de Recherches Aerospatiales, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 16p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper attempts to review the status of computational simulation of hypersonic flow achieved in Europe (except for the work performed in the countries of the former Soviet Union) within the past five to ten years. It is shown that national and concerted European efforts fostered the development of CFD in intimate combination with experimental work, in particular for validation purposes. It is believed that the state achieved, although not yet perfect, will be of tremendous help for the design process of an operational vehicle.
Derived from text
Hypersonic Flow; Simulation; Computational Fluid Dynamics; Europe

19980018687 Arizona State Univ., Tempe, AZ United States
DRAG PREDICTION AND TRANSITION IN HYPERSONIC FLOW
Reed, Helen L., Arizona State Univ., USA; Kimmel, Roger, Wright Lab., USA; Schneider, Steven, Purdue Univ., USA; Arnal, Daniel, Office National d'Etudes et de Recherches Aerospatiales, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 18p; In English; See also 19980018672
Contract(s)/Grant(s): F49620-97-0037; NAG1-1886; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper discusses progress on issues such as instability studies, nose-bluntness and angle-of-attack effects, and leading-edge-contamination problems from theoretical, computational, and experimental points of view. Also included is a review of wind-tunnel and flight data, including high-Re flight transition data, the levels of noise in flight and in wind tunnels, and how noise levels can affect parametric trends. A review of work done on drag accounting and the role of viscous drag for hypersonic vehicles is also provided.
Derived from text
Hypersonic Flow; Angle of Attack; Drag; Leading Edges; Noise Intensity

19980018693 NASA Langley Research Center, Hampton, VA United States
HYPERSONIC FLIGHT EXPERIMENTATION - STATUS AND SHORTFALLS
Bushnell, Dennis M., NASA Langley Research Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 8p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

For some 50 years, man has flown, very successfully, in and through the hypersonic flow regime up to Mach Number 35 and beyond with very few "surprises." In general, hypersonic vehicles have performed successfully with good-to-excellent comparisons between flight, ground facility extrapolations and computations being the norm. A consistent and glaring shortfall to date is in the boundary layer transition arena, due primarily to the dominance for flight vehicles of roughness induced transition where the roughness characteristics are extremely vehicle specific and dictated by either vehicle operational exigencies such as antennas, handling plugs, and field joints, etc. or characteristics of the thermal protection system. Emerging shortfalls for future systems which require research flight tests include transition and air-breathing propulsion-related technology for both cruise and space access. Specific flight test recommendations include "systems demonstrations" for various air-breathing propulsion options and efforts to correct a pervasive lack of adequate analysis of the existing, and very expensive to replicate, hypersonic flight data base.
Derived from text
Hypersonic Flight; Hypersonic Flow; Boundary Layer Transition; Hypersonic Vehicles; Flight Tests; Surface Roughness

19980018698 Daimler-Benz Aerospace A.G., Munich, Germany
AEROTHERMODYNAMICS AND PROPULSION INTEGRATION: SYNTHESIS OF THE AGARD-FDP-VKI SPECIAL COURSE, APRIL 15-19, 1996
Hirschel, E. H., Daimler-Benz Aerospace A.G., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 8p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The AGARD-FDP-VKI Special Course "Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles" dealt with basic topics of aerothermodynamics, with configurational aerothermodynamic of re-entry vehicles, airbreathing vehicles and missiles, and with inlet and aerothermodynamic airframe/propulsion integration of RAM and SCRAM propelled vehicles. In this paper the contributions, which were devoted to aerothermodynamic airframe/propulsion integration in the widest sense, are synthesized. After a general discussion of the problem, the main topics forebody, inlet, nozzle/afterbody, the whole vehicle, are detailed, partly with illustrating examples. Finally the potentials and deficits of simulation means are considered.
Derived from text
Aerothermodynamics; Air Breathing Engines; Engine Airframe Integration; Hypersonic Vehicles; Forebodies; Simulation; Inlet Nozzles; Afterbodies

19980020537 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
NON-LINEAR NONSTEADY EFFECTS IN THE HYDRODYNAMICS OF THE OSCILLATING WING
Dovgiy, S. A., Academy of Sciences of the Ukraine, Ukraine; Feb. 1998; 9p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The article presents the analysis of the nonsteady hydroaerodynamic characteristics of the oscillating wing with the infinite span performing the function of the propulsor. The results are received for the non-linear theory by means of the discrete vortices method. The comparison of data is conducted based on the quasisteady approach, linear and non-linear theories. It is also noted that for those modes of the wing motion which are able to simulate the operation of the wing propulsors of hydrobionts valid results can be given with the help of the nonsteady theory only.
Author
Nonlinearity; Oscillating Flow; Vortices; Infinite Span Wings; Hydrodynamics

19980035021 Wright Lab., FFI, Wright-Patterson AFB, OH United States
FOREBODY VORTEX CONTROL
Walchli, Lawrence A., Wright Lab., USA; Moorhouse, David J., Wright Lab., USA; Advances in Flight Testing; Dec. 1997; 18p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Much attention has been focussed in recent years on tactical maneuvering in post-stall flight. Such programs as the X31, VISTA/MATV, and the X-29A have established that tactical supermaneuverability at very high Angles of Attack (AOA) is a potent offensive weapon provided that the adversary can be enticed into close-in combat. Never before have requirements for integrating the pilot and aircraft been so important. The aircraft must have robust control authority in all axes, plenty of excess thrust, and pilot-friendly controls which allow him to fly to the limits of both his and the aircraft capability. Modern fighter aircraft operating above about 25 deg. AOA encounter a destabilizing phenomena caused by the complex three-dimensional separated vortical flowfield surrounding it. It is in this same region of flight that the aircraft wings and fuselage begin blanking the rudder, resulting in both degraded directional stability and control authority. Hence, two requirements emerge; increase directional stability and increase directional control authority. Thrust vectoring has been demonstrated as a means to increase control authority at all angles of attack. A potential way to increase directional stability could be by controlling the

forebody vortex flow. The primary object of this paper is to document an attempt to increase the directional stability of an F16 aircraft at all angles of attack into the post-stall regime. A wind tunnel test program had previously shown beneficial effects of forebody chines; additional testing provided stability and control data to support a flight test program. Flight tests were conducted with and without chines as a small adjunct to a program investigating thrust vectoring to very high angles of attack, the F-16 VISTA/MATV program. Specific maneuvers up to C(sub Lmax) (and beyond) were assessed to determine the major effects of forebody chines, although parameter identification was not an objective of the program. This paper describes the results of this effort.
Author
Vortices; Maneuvers; Angle of Attack; Fighter Aircraft; Forebodies; Parameter Identification

19980202470 NASA Langley Research Center, Hampton, VA United States
CALCULATED VISCOUS AND SCALE EFFECTS ON TRANSONIC AEROELASTICITY
Edwards, John W., NASA Langley Research Center, USA; Mar. 1998; 11p; In English; See also 19980202469; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A viscous-inviscid interactive coupling method is used for the computation of unsteady transonic flows. A lagextrainment integral boundary layer method is used with a transonic small disturbance potential code to compute the transonic aeroelastic response for two wing flutter models. By varying the modeled length scale, viscous effects may be studied as the Reynolds number per reference chord-length varies. Appropriate variation of modeled frequencies and generalized masses then allows comparison of responses for varying scales or Reynolds number. Two wing planforms are studied: one a four percent thick swept wing and the other a typical business jet wing. Calculations for both wings show limit cycle oscillations at transonic speeds in the vicinity of minimum flutter speed indices.
Author
Transonic Flow; Viscous Flow; Scale Effect; Aeroelasticity; Aerodynamic Stability; Unsteady Aerodynamics; Mathematical Models; Inviscid Flow; Flutter Analysis; Wing Oscillations; Transonic Flutter

19980202471 Dassault Aviation, Saint-Cloud, France
AEROELASTICITY AND C.F.D. *AEOELASTICITE ET C.F.D.*
Petiau, C., Dassault Aviation, France; Stoufflet, B., Dassault Aviation, France; Nicot, Ph., Dassault Aviation, France; Mar. 1998; 16p; In English; In French; See also 19980202469; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

We present the evolution of the use of CFD methods within our system of aeroelastic analysis (ELFINI). We started from a tool founded on the coupling of a structural Finite Element(FE) model and of an aerodynamic model, based on linear potential theory, empirically calibrated (mainly from flight tests). The linear character of these models allows a very efficient organization of inexpensive calculations (notions of load basis and of aerodynamic basis), sweeping of all of the flight configurations (Mach, altitudes, maneuvers, mass and external store configurations). Presently, keeping the same organization, we use an Euler FE method for the effects of initial shapes and of rigid motions. Now we push our developments in two main directions: non linear methods of direct static and dynamic coupling with aerodynamic models by non linear potential methods and mainly by steady and unsteady FE Euler methods; and linearized Euler methods in the neighborhood of previous non linear static aeroelastic solutions. In conclusion, we evoke the main features of our future organization of aeroelasticity analysis which will be more accurate while remaining affordable.
Author
Aeroelasticity; Computational Fluid Dynamics; Nonlinearity; Linearization; Euler Equations of Motion; Finite Element Method

19980202472 NASA Langley Research Center, Hampton, VA United States
APPLICATION OF THE ENS3DAE EULER/NAVIER-STOKES AEROELASTIC METHOD
Schuster, David M., NASA Langley Research Center, USA; Beran, Philip S., Air Force Inst. of Tech., USA; Huttsell, Lawrence J., Air Force Research Lab., USA; Numerical Unsteady Aerodynamic and Aeroelastic Simulation; Mar. 1998; 11p; In English; See also 19980202469 Contract(s)/Grant(s): F33615-95-D-3214; AF Proj. 0003; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper discusses recent applications of the ENS3DAE computational aeroelasticity method. In particular, it describes aeroelastic and unsteady aerodynamics calculations performed on wings with trailing edge control surfaces. These simulations include the investigation of control reversal for a structurally flexible wing with a deflected control surface, and a static and dynamic analysis of a rigid wing with an oscillating control surface. The two sets of calculations were performed independently on different wings using different grid topologies. The control reversal simulation represents an inviscid Euler static aeroelastic analysis of a thin wing with a rectangular planform. The geometry of this wing makes it suitable for computations using more approximate, inviscid aerodynamics methods. Thus, the results of the present Euler computations are compared with numerical data generated by a validated computational aeroelasticity code which uses a simpler aerodynamic formulation. The second illustrated case involves the simulation of a significantly more complex flowfield and the static and dynamic analyses of this geometry were performed using the viscous Navier-Stokes equation option in ENS3DAE. Results of both the steady and unsteady calculations on this wing are compared with existing experimental data.
Author
Aeroelasticity; Control Surfaces; Navier-Stokes Equation; Unsteady Aerodynamics; Computational Fluid Dynamics; Mathematical Models; Control Simulation

19980202473 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Aeroelasticity, Goettingen, Germany
AERODYNAMICS FOR ELASTICALLY OSCILLATING WINGS USING THE VIRTUAL GRID DEFORMATION METHOD
Wegner, W., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Mar. 1998; 12p; In English; See also 19980202469; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A new, efficient, and precise calculation method for unsteady aerodynamics is presented in this paper. It is called the "virtual grid deformation" method. The time-dependent grid deformation is observed virtually and without restriction, meaning that this method is also valid for high deflections and large amplitudes, respectively. This method is applicable to the conservation laws of fluid flows which are solved by a finite volume scheme and by a time-stepping procedure. Numerical results of a standard wing in steady and unsteady flow are compared with available measurements.
Author
Unsteady Aerodynamics; Finite Volume Method; Oscillating Flow; Mathematical Models; Unstructured Grids (Mathematics); Conservation Laws; Computational Fluid Dynamics

19980202474 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
APPLICATION OF LINEARIZED EULER EQUATIONS TO THE ESTIMATION OF FLOTATION *APPLICATION DES EQUATIONS D'EULER LINEARISEES A LA PREVISION DU FLOTTEMENT*
Mortchelewicz, G. D., Office National d'Etudes et de Recherches Aerospatiales, France; Numerical Unsteady Aerodynamic and Aeroelastic Simulation; Mar. 1998; 8p; Translated in English by Schreiber; In French; See also 19980202469; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The use of linearized Euler equations in the context of harmonic excitations of structural modes makes it possible to calculate the aeroelastic forces in the frequency field at a reduced calculation cost which is well below the cost obtained by the classical method of time simulation using the Euler equations. Numerical examples make it possible to illustrate this approach.
Transl. by Schreiber
Aeroelasticity; Euler Equations of Motion; Linearization; Computerized Simulation; Harmonic Excitation; Structural Stability; Frequency Distribution; Mathematical Models

19980202476 Boeing Co., Long Beach, CA United States
CFD BASED CORRECTIONS FOR LINEAR AERODYNAMIC METHODS
Baker, Myles L., Boeing Co., USA; Mar. 1998; 12p; In English; See also 19980202469; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In the past few years, great strides have been made in the analytical prediction of nonlinear flows using computational fluid dynamics (CFD). Coupled with the exponential growth in computer power, this has made it possible to analytically predict the unsteady aerodynamics and aeroelastic motion of complex configurations in nonlinear flow regimes. Unfortunately, these analyses are extremely costly due to the vast amount of computational effort required to compute the requisite time histories. This computational expense limits the use of these nonlinear aeroelastic tools to special cases, and eliminates them from consideration whenever a large number of conditions must be evaluated. Due to this high cost, the aerodynamic tools used in certification analysis and aeroelastic design optimization are usually based on linear lifting surface theory or panel methods. This paper presents a method to bridge this gap, so that the improved accuracy of the expensive nonlinear aerodynamic/aeroelastic methods can be injected into the economical production-type aeroelastic analyses through corrections to the linear aerodynamics. In contrast to techniques based on multiplicative correction factors, the present technique corrects the linear aerodynamics by removing a component of the pressure distribution from the linear theory, and replacing it with a component computed with a nonlinear method using a concept called "local equivalence." This allows a small number of nonlinear analyses to be applied to a large number of aeroelastic analyses. The technique is equally applicable to steady and unsteady aerodynamics. The formulation is such that, if available, steady or unsteady wind tunnel data can also be used in aeroelastic analysis and optimization. The scope of the paper is limited to comparing the results of corrected linear aerodynamics to the available nonlinear data, since many comparisons between nonlinear simulations and experiment are available in the literature. An application of the current technique to the flutter analysis of the AGARD 445.6 wing is shown, along with correlations between direct nonlinear flutter simulations and flutter solutions with corrected aerodynamics.
Author
Computational Fluid Dynamics; Unsteady Aerodynamics; Error Correcting Codes; Flutter Analysis; Flutter; Nonlinearity; Mathematical Models; Unsteady Flow

19980202478 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Aeroelasticity, Goettingen, Germany
TRANSONIC AEROELASTIC SIMULATION OF A FLEXIBLE WING SECTION
Schulze, Silvio, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Mar. 1998; 20p; In English; See also 19980202469; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Flutter characteristics and results of aeroelastic time response analyses of NACA64010 airfoils oscillating in transonic flow are presented. These solutions were obtained by a newly developed two-dimensional aeroelastic simulation code which is designed in such a manner that the flow and the structure can be modelled independently by using the so-called domain decomposition approach. The coupled field problem is then effectively solved in the time domain by applying a partitioned solution procedure in which the fluid and the structural solvers are executed in an alternating fashion and exchange interface data only at certain time steps. In this study the prediction of the flow field around airfoils in arbitrary motion is based on the solution of the unsteady Euler equations. The structure might either be modelled as a rigid body system or as a more realistic flexible configuration. In this context, the finite element method is used to model elastic effects in the chordwise direction of a typical wing section, thus accounting for more general motions of the airfoil including the fluid structure interaction boundary. The underlying theory is briefly outlined and results are presented for several aeroelastic test cases of varying complexity in the structural model. Both cases with and without control surface are dealt with and the effect of flexibility on the transonic aeroelastic stability behavior is investigated.
Author
Transonic Flow; Unsteady Flow; Flexible Wings; Airfoils; Aeroelasticity; Computerized Simulation; Finite Element Method; Euler Equations of Motion; Dynamic Response; Control Surfaces; Two Dimensional Models; Mathematical Models; Transonic Flutter; Computational Fluid Dynamics

19980202479 National Aerospace Lab., Amsterdam, Netherlands
NLR-TUDELFT EXPERIENCE IN UNSTEADY AERODYNAMICS AND AEROELASTIC SIMULATION APPLICATIONS
Meijer, J. J., National Aerospace Lab., Netherlands; Hounjet, M. H. L., National Aerospace Lab., Netherlands; Eussen, B. J. G., National Aerospace Lab., Netherlands; Prananta, B. B., Technische Hogeschool, Netherlands; Mar. 1998; 21p; In English; See also 19980202469
Contract(s)/Grant(s): NIVR-01904N; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The development of computational aerodynamic and aeroelastic simulation codes is steadily making progress. Nevertheless these codes are only modestly being accepted by the end-users in industry and other agencies in charge of flutter clearance or aeroelastic responses, in general. Various shortcomings of the current codes can be named which cause the reserve of the end-users. One of them is often unacceptable amount of manpower required for pre- and post-processing. NLR is developing a numerical aeroelastic simulation environment for applications to civil and fighter-type aircraft, of which a pilot version is in operation. Special attention has been given to the design of user friendly pre and postprocessing. The paper will discuss the motivation of an aeroelastic simulation environment, the status of the NLR AEroelastic SIMulation system, the current research activities, the pre and postprocessing and future research activities. Several applications will be shown, demonstrating the use to both civil and fighter-type aircraft.
Author
Unsteady Aerodynamics; Aeroelasticity; Computational Fluid Dynamics; Computerized Simulation; Flutter; Three Dimensional Models; Aircraft Models; Mathematical Models; Wing Oscillations; Aerodynamic Characteristics

19980202481 Daimler-Benz Aerospace A.G., Military Aircraft, Munich, Germany
HIGH INCIDENCE UNSTEADY AERODYNAMICS FOR AEROSERVOELASTIC PREDICTIONS
Luber, W., Daimler-Benz Aerospace A.G., Germany; Becker, J., Daimler-Benz Aerospace A.G., Germany; Numerical Unsteady Aerodynamic and Aeroelastic Simulation; Mar. 1998; 16p; In English; See also 19980202469; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The aeroservoelastic stability of a fighter type aircraft is investigated at high angle of attack. The effects of non-linear, incidence dependent unsteady aerodynamic forces of elastic modes and of control surface deflections on the structural coupling are demonstrated for low and high subsonic speeds for different incidences. The difference of open loop frequency response functions calculated with linear and with high angle of attack unsteady aerodynamics documents the necessity of introduction of high incidence effects for aeroservoelastic stability calculations. Non-linear effects are introduced using unsteady pressures of windtunnel experiments on an oscillation model by correcting of theoretical pressures.
Author
Aerodynamic Forces; Aeroservoelasticity; Angle of Attack; Control Surfaces; Unsteady Aerodynamics; Subsonic Speed; Wing Oscillations; Fighter Aircraft; Deflection; Wind Tunnel Models; Wind Tunnel Tests; Computational Fluid Dynamics; Wind Pressure

19980202482 ZONA Technology, Inc., Mesa, AZ United States
A UNIFIED UNSTEADY AERODYNAMIC MODULE FOR AEROELASTIC AND MDO APPLICATIONS
Chen, P. C., ZONA Technology, Inc., USA; Sarhaddi, d., ZONA Technology, Inc., USA; Liu, D. D., Arizona State Univ., USA; Mar. 1998; 14p; In English; See also 19980202469; Sponsored in part by Air force STTR.; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Recent advances in the lifting surface methods are attributed to the possible generalization of the Aerodynamic Influence Coefficient (AIC) method to the Transonic and Hypersonic flight regimes. Thus a unified AIC (UAIC) approach has been developed for aeroelastic/MDO applications in the complete Mach number range. A typical CFD method usually requires CFD/CSD interfacing in a time-domain aeroelastic analysis, while additional grid generation effort is needed in each MDO design cycle. The former procedure is still underdeveloped and the latter could be costly. Free from these procedures, the present UAIC is fully compatible with classical linear aeroelastic matrix equa-

tions. Thus, the UAIC approach as an unsteady aerodynamic module can be readily integrated with current standard FEM systems or into a MDO environment, practiced by aerospace industries. Specifically, the present module consists of four major unsteady aerodynamic codes which jointly cover all flight regimes, thereby rendering the module unified for all Mach numbers. First, the capability of the present aerodynamic module will be discussed. Second, the seamless integration of the present aero module with a MDO software ASTROS is properly defined. Third, cases studied for the validation of the integrated aerodynamic module will be presented. These include: supersonic analysis of a swept untapered wing, a fighter wing with transonic flutter constraint and a rectangular wing in roll with control surface reversal. Finally, we will present our concept of computational aeroelasticity in terms of Aeroelasticity Modeling Methodology (AIC methods) and Aeroelasticity Simulation Methodology (CFD methods) from the standpoint of industrial application. We believe that these two methodologies, if their practices follow the proposed global strategy, could compliment each other in achieving further computational expediency and with wider applicability.
Author
Aeroelasticity; Unsteady Aerodynamics; Grid Generation (Mathematics); Transonic Flutter; Control Surfaces; Computational Fluid Dynamics; Computerized Simulation; Mathematical Models; Subroutines; Flutter Analysis; Applications Programs (Computers)

19980202483 Saab Aircraft Co., Flutter and Loads Dept., Linkoeping, Sweden
EXPERIENCE WITH UNSTEADY AERODYNAMICS COMPUTATION FOR SAAB AIRCRAFT
Franzen, Bo, Saab Aircraft Co., Sweden; Nilsson, Bo, Saab Aircraft Co., Sweden; Winzell, Bengt, Saab Aircraft Co., Sweden; Mar. 1998; 12p; In English; See also 19980202469; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Unsteady aerodynamics plays a vital role in the design of an aircraft. Already in the initial phase it is necessary to have reliable estimates of flutter boundaries and to supply information for control system software and hardware. Thus speed and accuracy of unsteady aerodynamic computation are required. In practice, it is natural to depend mainly on computations based on linear theory. There are situations where speed of computation and accuracy are contradictory, and then one must resort to previous experience and correction strategies. The elastic modern aircraft is becoming more and more aeroservo-elastic. The quality of simulation of the numerous feedback mechanisms is highly dependent on the accuracy of control surface aerodynamics. Moreover, the frequent application of multi-disciplinary optimization puts strong new demands on unsteady aerodynamic accuracy. In this paper, we will show examples of validating experiments and computations, and discuss applications of classical and new methods for real civil and military aircraft.
Author
Unsteady Aerodynamics; Applications Programs (Computers); Control Surfaces; Wing Oscillations; Aeroservoelasticity; Transonic Flutter; Aerodynamic Loads; Mathematical Models; Dynamic Response

19980203997 Boeing Commercial Airplane Co., Aerodynamics Lab., Seattle, WA United States
AIRPLANE FLOW-FIELD MEASUREMENTS AND THE FLYING STRUT
Crowder, J. P., Boeing Commercial Airplane Co., USA; May 1998; 8p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The prospect for useful measurements of airplane flow-field properties are reviewed. Early experience in flow-field measurements at Boeing is described, as are the requirements for quantitative flow-field surveys in industrial wind tunnels. Recent examples of quantitative flow-field measurements of lift and drag distributions in subsonic and transonic wind tunnels are presented. A new invention, called the Flying Strut, is introduced as a practical system for flow-field surveys in large wind tunnels and in flight.
Author
Aircraft Design; Transonic Wind Tunnels; Subsonic Wind Tunnels; Flow Distribution; Struts

19980204006 NASA Ames Research Center, Moffett Field, CA United States
DEVELOPMENT OF HIGH SPEED INTERFEROMETRY IMAGING AND ANALYSIS TECHNIQUES FOR COMPRESSIBLE DYNAMIC STALL
Chandrasekhara, M. S., Naval Postgraduate School, USA; Carr, L. W., NASA Ames Research Center, USA; Wilder, M. C., MCAT Inst., USA; May 1998; 12p; In English; See also 19980203985
Contract(s)/Grant(s): ARO-MIPR-96-7; AF-AFOSR-MIPR-0004-92; AF-AFOSR-ISSA-0067-89; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The development of a high-speed, phase-locked, realtime, point diffraction interferometry system for quantitative imaging unsteady separated flows is described. The system enables recording of up to 224 interferograms of the dynamic stall flow over an oscillating airfoil using a drum camera at rates of up to 40 KHz controlled by custom designed electronic interlocking circuitry. Several thousand interferograms of the flow have been obtained using this system. A comprehensive image analysis package has been developed for automatic processing of this large number of images. The software has been specifically tuned to address the special characteristics of airfoil flow interferograms. Examples of images obtained using the standard and the high-speed interferometry techniques are presented along with a demonstration of the image processing routine's ability to resolve the fine details present in these images.
Author
Aerodynamic Stalling; Imaging Techniques; Interferometry; Image Processing; Airfoils

19980204014 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia
STUDY RESULT FOR THE APPLICATION OF TEO-COMPONENT PSP TECHNOLOGY TO AERODYNAMIC EXPERIMENT
Bykov, A., Tsentralni Aerogidrodinamicheskii Inst., Russia; Fonov, S., Tsentralni Aerogidrodinamicheskii Inst., Russia; Mosharov, V., Tsentralni Aerogidrodinamicheskii Inst., Russia; Orlov, A., Tsentralni Aerogidrodinamicheskii Inst., Russia; Pesetsky, V., Tsentralni Aerogidrodinamicheskii Inst., Russia; Radchenko, V., Tsentralni Aerogidrodinamicheskii Inst., Russia; May 1998; 8p; In English; See also 19980203985
Contract(s)/Grant(s): ARO Proj. N36439-EG; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The increase in the PSP measurement accuracy in wind tunnels is related first of all to the application of the two-component PSP technology. Besides the active luminophor the luminescence of which depends on pressure, the two-component PSP formulation also contains an additional luminophor. The simultaneous measurement of the luminescence intensities of the active luminophor and the additional luminophor makes it possible to avoid numerous difficulties characteristic of the one-component PSP technology. Consideration is given to some processes affecting the two-component PSP measurement accuracy. The transonic wind tunnel investigations of the two-component PSP are presented. Also, the first results of investigating the possibilitiy of applying PSP pressure measurements to the helicopter rotor blade using the two-component PSP are given.
Author
Aerodynamics; Pressure Measurement; Aircraft

19980204015 Office National d'Etudes et de Recherches Aerospatiales, Modane, France
THE TWO-COMPONENT PSP INVESTIGATION ON A CIVIL AIRCRAFT MODEL IN S2MA WIND TUNNEL
Lyonnet, Marianne, Office National d'Etudes et de Recherches Aerospatiales, France; Deleglise, Bruno, Office National d'Etudes et de Recherches Aerospatiales, France; Grenat, Gerard, Office National d'Etudes et de Recherches Aerospatiales, France; Bykov, A., Tsentralni Aerogidrodinamicheskii Inst., Russia; Mosharov, V., Tsentralni Aerogidrodinamicheskii Inst., Russia; Orlov, A., Tsentralni Aerogidrodinamicheskii Inst., Russia; Fonov, S., Tsentralni Aerogidrodinamicheskii Inst., Russia; May 1998; 8p; In English; See also 19980203985; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Pressure sensitive paint (PSP) is a technology of major interest to wind tunnel operators. As part of the cooperation programme between ONERA and TsAGI an evaluation test of the optical pressure measurement system developed by TsAGI was performed in the tran-

sonic test section of the S2MA wind tunnel at the Modane centre. The tests were carried out on an Airbus model loaned by Aerospatiale. The left wing was instrumented with 240 pressure taps, the right wing was covered by a two-component PSP, developed by the Russian firm OPTROD. Experimental set-up, characteristics of the two component paint and data processing are described. Comparisons between results from conventional and PSP measurements are presented, and the effects of incidence, Mach number, pressure and temperature are discussed.
Author
Aircraft Models; Civil Aviation; Optical Measurement; Pressure Distribution; Pressure Measurement

19980204016 NASA Ames Research Center, Moffett Field, CA United States
LOW-SPEED FLOW STUDIES USING THE PRESSURE SENSITIVE PAINT TECHNIQUE
Brown, O. C., Stanford Univ., USA; Mehta, R. D., NASA Ames Research Center, USA; Cantwell, B. J., Stanford Univ., USA; May 1998; 14p; In English; See also 19980203985; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Optical pressure measurements have been made on a NACA 0012 airfoil coated with Pressure Sensitive Paint (PSP) at very low flow speeds (less than 50 m/s). Angle of attack was limited to 5 deg. for most measurements. Effects of temperature gradients and mis-registration errors on PSP response have been established and minimized. by reducing measurement error caused by these effects. PSP sensitivity has been enhanced. Acceptable aerodynamic data at flow speeds down to 20 m/s have been obtained and valid pressure paint response was observed down to 10 m/s. Measurement errors (in terms of pressure and pressure coefficient) using PSP with pressure taps as a reference are provided for the range of flow speeds from 50 m/s to 10 m/s.
Author
Aerodynamics; Paints; Coatings; Airfoils; Pressure Measurement; Temperature Effects

19980204019 NASA Langley Research Center, Hampton, VA United States
MODEL DEFORMATION MEASUREMENTS AT NASA LANGLEY RESEARCH CENTER
Burner, A. W., NASA Langley Research Center, USA; May 1998; 10p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Only recently have large amounts of model deformation data been acquired in NASA wind tunnels. This acquisition of model deformation data was made possible by the development of an automated video photogrammetric system to measure the changes in wing twist and bending under aerodynamic load. The measurement technique is based upon a single view photogrammetric determination of two dimensional coordinates of wing targets with a fixed third dimensional coordinate, namely the spanwise location. A major consideration in the development of the measurement system was that use of the technique must not appreciably reduce wind tunnel productivity. The measurement technique has been used successfully for a number of tests at four large production wind tunnels at NASA and a dedicated system is nearing completion for a fifth facility. These facilities are the National Transonic Facility, the Transonic Dynamics Tunnel, and the Unitary Plan Wind Tunnel at NASA Langley, and the 12-FT Pressure Tunnel at NASA Ames. A dedicated system for the Langley 16-Foot Transonic Tunnel is scheduled to be used for the first time for a test in September. The advantages, limitations, and strategy of the technique as currently used in NASA wind tunnels are presented. Model deformation data are presented which illustrate the value of these measurements. Plans for further enhancements to the technique are presented.
Author
Aerodynamic Loads; Deformation; Aircraft Models; Wind Tunnels

19980204020 Case Western Reserve Univ., School of Engineering, Cleveland, OH United States
MEMS APPLICATIONS IN AERODYNAMIC MEASUREMENT TECHNOLOGY
Reshotko, E., Case Western Reserve Univ., USA; Mehregany, M., Case Western Reserve Univ., USA; Bang, C., Advanced Micromachines, Inc., USA; May 1998; 10p; In English; See also 19980203985 Contract(s)/Grant(s): F49620-96-I-0482; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Microelectromechanical systems (MEMS) embodies the integration of sensors, actuators, and electronics on a single substrate using integrated circuit fabrication techniques and compatible bulk and surface micromachining processes. Silicon and its derivatives form the material base for the MEMS technology. MEMS devices, including microsensors and microactuators, are attractive because they can be made small (characteristic dimension about 100 microns), be produced in large numbers with uniform performance, include electronics for high performance and sophisticated functionality, and be inexpensive. For aerodynamic measurements, it is preferred that sensors be small so as to approximate measurement at a point, and in fact, MEMS pressure sensors, wall shear-stress sensors, heat flux sensors and micromachined hot wires are nearing application. For the envisioned application to wind tunnel models, MEMS sensors can be placed on the surface or in very shallow grooves. MEMS devices have often been fabricated on stiff, flat silicon substrates, about 0.5 mm thick, and therefore were not easily mounted on curved surfaces. However, flexible substrates are now available and heat-flux sensor arrays have been wrapped around a curved turbine blade. Electrical leads can also be built into the flexible substrate. Thus MEMS instrumented wind tunnel models do not require deep spanwise grooves for tubes and leads that compromise the strength of conventionally instrumented models. With MEMS, even the electrical leads can potentially be eliminated if telemetry of the signals to an appropriate receiver can be implemented. While semiconductor silicon is well known for its electronic properties, it is also an excellent mechanical material for MEMS applications. However, silicon electronics are limited to operations below about 200 C, and silicon's mechanical properties start to diminish above 400 C. In recent years, silicon carbide (SiC) has emerged as the leading material candidate for applications in high temperature environments and can be used for high-temperature MEMS applications. With SiC, diodes and more complex electronics have been shown to operate to about 600 C, while the mechanical properties of SiC are maintained to much higher temperatures. Even when MEMS devices show benefits in the laboratory, there are many packaging challenges for any aeronautics application. Incorporating MEMS into these applications requires new approaches to packaging that goes beyond traditional integrated circuit (IC) packaging technologies. MEMS must interact mechanically, as well as electrically with their environment, making most traditional chip packaging and mounting techniques inadequate. Wind tunnels operate over wide temperature ranges in an environment that is far from being a 'clean-room.' In flight, aircraft are exposed to natural elements (e.g. rain, sun, ice, insects and dirt) and operational interferences(e.g. cleaning and deicing fluids, and maintenance crews). In propulsion systems applications, MEMS devices will have to operate in environments containing gases with very high temperatures, abrasive particles and combustion products. Hence deployment and packaging that maintains the integrity of the MEMS system is crucial. This paper presents an overview of MEMS fabrication and materials, descriptions of available sensors with more details on those being developed in our laboratories, and a discussion of sensor deployment options for wind tunnel and flight applications.
Author
Aerodynamics; Mechanical Properties; Micromachining; Semiconductors (Materials); Wind Tunnel Tests; Turbine Blades

19980236568 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
WIND TUNNEL WALL CORRECTIONS *LA CORRECTION DES EFFETS DE PAROI EN SOUFFLERIE*
Ewald, B. F. R., Editor, Technische Univ., Germany; Oct. 1998; 560p; In English
Report No.(s): AGARD-AG-336; ISBN 92-836-1076-8; Copyright Waived; Avail: CASI; A24, Hardcopy; A04, Microfiche

This AGARDograph has been compiled by an international team of wind tunnel wall correction experts. The state of the art in wall corrections is presented with special emphasis given to the description of modern methods based on Computational Fluid Dynamics (CFD). Topics covered include: Open Test Sections, Closed Test Sections, Ventilated Test Sections, Boundary Measurement Methods, Transonic Wall Interference, Bluff Body Corrections, Adaptive Walls, Panel Methods, and CFD Methods.
Author
Wall Flow; Boundary Layer Flow; Computational Fluid Dynamics; Boundary Conditions; Aerodynamic Interference; Wind Tunnel Walls; Correction

19990024922 NASA Langley Research Center, Hampton, VA United States
EXTRAPOLATION FROM WIND TUNNEL TO FLIGHT: SHUTTLE ORBITER AERODYNAMICS
Muylaert, J., European Space Agency. European Space Research and Technology Center, ESTEC, Netherlands; Walpot, L., European Space Agency. European Space Research and Technology Center, ESTEC, Netherlands; Rostand, P., Dassault Aviation, France; Rapuc, M., Dassault Aviation, France; Brauckmann, G., NASA Langley Research Center, USA; Paulson, J., NASA Langley Research Center, USA; Trockmorton, D., NASA Langley Research Center, USA; Weilmuenster, K., NASA Langley Research Center, USA; Hypersonic Experimental and Computational Capability, Improvement and Validation; December 1998; Volume 2; 15p; In English; See also 19990024917; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The paper reviews a combined numerical and experimental activity on the Shuttle Orbiter, first performed at NASA Langley within the Orbiter Experiment (OEX) and subsequently at ESA, as part of the AGARD FDP WG 18 activities. The study at Langley was undertaken to resolve the pitch up anomaly observed during the entry of the first flight of the Shuttle Orbiter. The present paper will focus on real gas effects on aerodynamics and not on heating. The facilities used at NASA Langley were the 15-in. Mach 6, the 20-in, Mach 6, the 31-in. Mach 10 and the 20-in. Mach 6 CF4 facility. The paper focuses on the high Mach, high altitude portion of the first entry of the Shuttle where the vehicle exhibited a nose-up pitching moment relative to pre-flight prediction of (Delta C(sub m)) = 0.03. In order to study the relative contribution of compressibility, viscous interaction and real gas effects on basic body pitching moment and flap efficiency, an experimental study was undertaken to examine the effects of Mach, Reynolds and ratio of specific heats at NASA. At high Mach, a decrease of gamma occurs in the shock layer due to high temperature effects. The primary effect of this lower specific heat ratio is a decrease of the pressure on the aft windward expansion surface of the Orbiter causing the nose-up pitching moment. Testing in the heavy gas, Mach 6 CF4 tunnel, gave a good simulation of high temperature effects. The facilities used at ESA were the Im Mach 10 at ONERA Modane, the 0.7 m hot shot F4 at ONERA Le Fauga and the 0.88 m piston driven shock tube HEG at DLR Goettingen. Encouraging good force measurements were obtained in the F4 facility on the Orbiter configuration. Testing of the same model in the perfect gas Mach 10 S4 Modane facility was performed so as to have "reference" conditions. When one compares the F4 and S4 test results, the data suggests that the Orbiter "pitch up" is due to real gas effects. In addition, pressure measurements, performed on the aft portion of the windward side of the Halis configuration in HEG and F4, confirm that the pitch up is mainly attributed to a reduction of pressure due to a local decrease in gamma.
Author
Mach Number; Pitching Moments; Real Gases; Laminar Flow; Wind Tunnel Tests; Reynolds Number; Hypersonic Flow; Oxygen; Computational Fluid Dynamics; Nitrogen

19990024923 NASA Ames Research Center, Moffett Field, CA United States
REAL-GAS AEROTHERMODYNAMICS TEST FACILITIES
Arnold, James O., NASA Ames Research Center, USA; Seibert, George L., Wright Lab., USA; Wendt, John F., Von Karman Inst. for Fluid Dynamics, Belgium; Hypersonic Experimental and Computational Capability, Improvement and Validation; December 1998; Volume 2; 29p; In English; See also 19990024917; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This chapter provides an overview of the current ground-based aerothermodynamic testing capabilities in Western Europe and the USA. The focus is on facilities capable of producing real-gas effects (dissociation, ionization, and thermochemical nonequilibrium) pertinent to the study of atmospheric flight in the Mach number range of 5 <M <50. Perceived mission needs of interest to the Americans and Western Europeans are described where such real-gas flows are important. The role of Computational Fluid Dynamics (CFD) in modern ground testing is discussed, and the capabilities of selected American and European real-gas facilities are described. An update on the current instrumentation in aerothermodynamic testing is also outlined. Comments are made regarding the use of new facilities which have been brought on line during the past 3-5 years. Finally, future needs for aerothermodynamic testing, including instrumentation, are discussed and recommendations for implementation are reported.
Derived from text
Computational Fluid Dynamics; Ground Tests; Real Gases; Test Facilities; Wind Tunnels; Ballistic Ranges; Shock Tunnels

03
AIR TRANSPORTATION AND SAFETY

19950024640 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
PILOT INDUCED OSCILLATIONS *ATELIER SUR LE POMPAGE PILOTE*
Feb 1, 1995; 117p; In English, May 1994; See also 19950024641 through 19950024651
Report No.(s): AGARD-AR-335; ISBN 92-836-1013-X; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

Instability of the pilot/airframe combination has been a problem of manned flight. Rapid advances made in aviation following World War 2 greatly increased the incidence of PIO problems and the amount of research and development work aimed at understanding and mitigating these difficulties. Criteria and requirements were developed to be used in design to obtain satisfactory PIO qualities, but, in spite of all this work and the great flexibility in available modern control design technologies, PIO problems still often occur with new aircraft. It is clear that a universal solution of the PIO problem still evades the engineering community. The cost of these problems financially and in program delay is significant. This AGARD Flight Mechanics Workshop summary report contains presentations and discussions that aim toward the elimination and avoidance of PIO's by increasing the knowledge of PIO's and the problems associated with them.
Active Control; Aerospace Engineering; Aircraft Control; Aircraft Stability; Conferences; Control Systems Design; Flight Control; Flight Mechanics; Longitudinal Control; Pilot Induced Oscillation

19950024641 NASA Hugh L. Dryden Flight Research Facility, Edwards, CA, United States
PIO: A HISTORICAL PERSPECTIVE
Mcruer, Duane T., Systems Technology, Inc., USA; Smith, R. E., NASA Hugh L. Dryden Flight Research Facility, USA; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 4 p; In English; See also 19950024640; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

These problems relating to Pilot Induced Oscillations have manifested themselves since the earliest days of manned flight. The earliest recorded examples of PIO date back to the Wright brothers first aircraft. The earliest filmed records date back to just prior to World War 2, with the XB-19 aircraft which suffered a pitch PIO just prior to touchdown. Four classes of PIO have been identified, into which all of the known incidents can be grouped. These are: (1) Essentially Single Axis, Extended Rigid Body Effective Vehicle Dynamics; (2) Essentially Single Axis, Extended Rigid Body with Significant Feel-System Manipulator Mechanical Control Elements; (3) Multiple Axis, Extended Rigid Body Effective Vehicle Dynamics; and (4) PIO's Involving Higher Frequency Modes.
Derived from text
Frequencies; Histories; Pilot Induced Oscillation; Pilot Performance

19950024642 NASA, Washington, DC, United States
THE PROCESS FOR ADDRESSING THE CHALLENGES OF AIRCRAFT PILOT COUPLING
Aharrah, Ralph, NASA, USA; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 3 p; In English; See also 19950024640; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The term 'Pilot Induced Oscillation' is misleading in that it places an undue emphasis on the role of the pilot in the process. Clearly, the phenomenon cannot occur in the absence of the pilot, but the term PIO suggests that the pilot is in some way responsible for the occurrence. He is not. The phenomenon may be better described by the title 'Aircraft-Pilot Coupling', or A-PC. This may be considered to better describe what is actually occurring when the pilot is trying to perform his normal function, i.e., that of controlling the aircraft which he is flying. For a designer, the objective should be to ensure that there is no possibility of A-PC occurring. Associated with this, the goal should also be to achieve Level 1 handling qualities. The key is to understand the Process involved in design and test and to ensure that this is exercised to achieve the objective. This has to be set alongside the management goals of better, faster and cheaper, in order that the manufacturer can remain competitive in the market.
Derived from text
Aircraft Control; Aircraft Design; Controllability; Flight Control; Pilot Induced Oscillation; Systems Integration

19950024643 High Plains Engineering, Tehachapi, CA, United States
OBSERVATIONS ON PIO
Smith, Ralph H., High Plains Engineering, USA; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 9 p; In English; See also 19950024640; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Comparison of the handling characteristics of a Porsche with those expected from a modern combat type aircraft indicate that we accept significantly poorer handling performance with the aircraft than we would with a high performance road vehicle. The work which led to the evolution of the Smith-Geddes criteria stems from work performed for the USAF in relation to the F-15 aircraft. The logic that arrived at the criteria stemmed from a belief that the existing handling qualities criteria were inadequate for assessing the Pilot Induced Oscillation (PIO) susceptibility of an aircraft, and that the only successful way to test for this was to use the methods of Handling Qualities During Tracking (HQDT). The work which was performed was offered for the update of Mil 1797, but was not incorporated. This presentation concentrated on the understanding of PIO and the process by which it originates, using a simple model to demonstrate the characteristics which are inherent. The presentation also provided an explanation of the Smith-Geddes criteria, without resorting to the detail of the theories which support the criteria. The major thrust relates to the application to the assessment of PIO susceptibility and includes a commentary on the state of the control law development, together with the associated flight test technology.
Derived from text
Aircraft Control; Controllability; Flight Control; Pilot Induced Oscillation

19950024645 Gibson (J. C.), Saint Annes, United Kingdom
LOOKING FOR THE SIMPLE PIO MODEL
Gibson, John C., Gibson (J. C.), UK; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 11 p; In English; See also 19950024640; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

Eighteen years after the Tornado PIO (Pilot induced Oscillation) was successfully resolved, it seems inexplicable that similar PIO problems can still occur. For whatever reason, current formal methods are not working. The Vista F-16 is a powerful tool which should be put to use in establishing a universally acceptable set of criteria for the prevention of PIO by design. It should do this by determining the PIO qualities of a sufficiently wide range of linear and non-linear dynamic qualities, both in pitch and in roll, to establish a customer-defined set of Level boundary limits on whatever parameters are found best to quantify PIO. Only by doing this will it be possible to resolve the claims of the many competing criteria and guarantee a PIO-free future for all. It is not particularly difficult to identify the means.
Derived from text
Aerodynamic Stability; Aircraft Control; Aircraft Stability; F-16 Aircraft; Mathematical Models; Pilot Induced Oscillation; Pilot Performance

19950024646 McDonnell-Douglas Aerospace, Transport Aircraft Unit., Long Beach, CA, United States
THE RELATION OF HANDLING QUALITIES RATINGS TO AIRCRAFT SAFETY
Hodgkinson, John, McDonnell-Douglas Aerospace, USA; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 3 p; In English; See also 19950024640; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The main theme of this presentation, is that of relating the handling qualities issues, and specifically the PIO, to aircraft safety. It is essential that the programme managers recognize that PIO is safety critical in that it is loss of control, and that when it is encountered, it is as dangerous as a structural failure of the airframe.
Derived from text
Aircraft Accidents; Aircraft Design; Aircraft Safety; Controllability; Flight Safety; Ratings; Technology Assessment

19950024647 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik., Brunswick, Germany
SCARLET: DLR RATE SATURATION FLIGHT EXPERIMENT
Martin, Jennifer R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Buchholz, Joerg J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 6 p; In English; See also 19950024640; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

The time delay which arises due to rate limiting in a control system has been identified as a contributing factor to the occurrence of pilot induced oscillations (PIO's). Recent discussions concerning PIO prevention measures have proposed the elimination of this time delay through an alternate control scheme. In response to this proposal, the SCARLET (Saturated Command and Rate Limited Elevator Time delay) project was initiated in order to study the effects of both the time delay and the elimination scheme on the handling qualities of a contemporary fly-by-wire aircraft. A flight experiment was carried out in 1992 using DLR's ATTAS In-Flight Simulator. The flight test included runs with two different control laws: a conventional control scheme and the alternate control scheme (ACS). Results of the experiment demonstrated both the negative effect of rate saturation and the effectiveness of ACS to reduce the equivalent time delay and improve tracking performance. In order to further validate the concept of an alternate control scheme, the algorithms were adapted for use with a model-following control system. Pilot-in-the-loop simulations have shown improved performance through the use of ACS during rate saturated conditions. A second flight test will be performed this year in order to further evaluate the use of the alternate control scheme to eliminate the rate limit induced time delay and reduce the danger of PIO.
Derived from text
Accident Prevention; Control Systems Design; Control Theory; Flight Simulation; Flight Tests; Fly by Wire Control; Optimal Control; Pilot Induced Oscillation; Time Lag

19950024648 Saab-Scania, Flight Control., Linkoeping, Sweden
SAAB EXPERIENCE WITH PIO
Kullberg, E., Saab-Scania, Sweden; Elgerona, Per-Olov, Saab-Scania, Sweden; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 9 p; In English; See also 19950024640; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

The past experience in Sweden with PIO is reviewed, which had been so publicly witnessed with the second accident to the JAS-39 aircraft at the Stockholm Water Festival. Prior to commencing on the JAS-39 project, SAAB's experience of the PIO phenomenon had commenced with the J-35 aircraft. This aircraft had high stick sensitivity combined with a linear gearing of the stick to elevon. Following the PIO, the solution devised was to add a nonlinear gearing and

improve the stability augmentation of the system. For the next aircraft project, the AJ-37 Viggen, significant work was performed on the handling qualities and resistance to PIO, based upon new information received during the 1960's from Ashkenas, McRuer, and A'Harrah. by 1963, Sweden had developed its own specification for flight control system design and for handling qualities. The latest versions of this AJ-37 aircraft have a digital flight control system. The AJ-37 Viggen has never experienced a problem with PIO in its service to date. The JAS-39 flight control system originated from demonstration work performed by SAAB on a FBW AJ-37 Viggen aircraft. This aircraft had been flown with instability levels of up to 4 percent chord at low Mach Number. This was the limit for this aircraft. Although this aircraft was reported to have experienced Level 2 or 3 handling, due to excessive time delays within the flight control system, it never experienced rate limiting or PIO. On this basis, it was deemed that there was sufficient knowledge and confidence to proceed with the JAS-39 aircraft project, and the JAS-39 specification was written around this experience, with a demanding handling qualities requirement.
Derived from text
Aircraft Accidents; Aircraft Control; Controllability; Flight Control; JAS-39 Aircraft; Pilot Induced Oscillation

19950024649 Department of the Air Force, California City, CA, United States
AEROELASTIC PILOT-IN-THE-LOOP OSCILLATIONS
Norton, W. J., Department of the Air Force, USA; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 14 p; In English; See also 19950024640; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

Pilot-induced oscillation (PIO) is an unwanted and inadvertent closed-loop coupling between the pilot and one or more independent response variables of an aircraft. PIO typically results when the pilot attempts to perform a high gain tracking task using the usual cues of acceleration or attitude. Control system and aircraft characteristics within the bandwidth in which the pilot is active can contribute to a coupling between the pilot response and aircraft dynamics. The result is a neutrally damped or undamped out-of-control condition in which the pilot is often making intentional extreme and repetitive inputs in an effort to damp the motion but only serves to enhance it. Pilot-augmented oscillation (PAO) is an unintentional closed-loop coupling which does not involve a tracking task. Another aircraft variable which may lead to PIO or PAO is aeroelastic deformation of the vehicle structure. This elastic response can produce pilot cues or aircraft rigid body motion which can be enhanced when the pilot attempts to damp the oscillation and PIO results. Or, the elastic oscillations alone may lead to PAO. The potential for aeroelastic pilot-in-the-loop coupling is not widely recognized, and this can mean resources expended in ineffectual or nonoptimal solutions to the problem until the aeroelastic source is recognized. This paper will characterize the aeroelastic/pilot coupling phenomena without reproducing the fundamental research which has already been published on more general PIO. Examples of aeroelastic PIO and PAO will be provided to illustrate the various ways in which the phenomena can manifest itself, including recent experiences with the C-17A and the V-22. An examination of the potential for predicting this coupling will also be provided. Lastly, recommendations for flight test methodology to uncover and investigate aeroelastic pilot-in-the-loop coupling will be provided.
Author
Aeroelasticity; Aircraft Control; Aircraft Stability; Controllability; Flight Characteristics; Pilot Induced Oscillation

19950024651 Chalk (Charles R.), Williamsville, NY, United States
CALSPAN EXPERIENCE OF PIO AND THE EFFECTS OF RATE LIMITING
Chalk, Charles R., Chalk (Charles R.), USA; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 12 p; In English; See also 19950024640; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

The experience of PIO within the Calspan Corporation is considerable, following a long standing interest in the subject. During this experience, the major concern that has been uncovered is that of the attitude towards the pilot following a PIO incident. There is still a tendency in many areas of aviation to consider a PIO as a failure of the pilot, whereas it must be properly regarded as a failure of the control system and its design process. Over a period of some years, the Calspan Corporation has undertaken a series of experiments with the NT-33A and Lear Jet aircraft to examine the effects of rate limiting compensating devices. The notes which follow summarize the presentation given on some of the aspects which have been investigated both analytically and experimentally in flight tests.
Derived from text
Aircraft Control; Computerized Simulation; Control Systems Design; Flight Control; Frequency Response; Mathematical Models; Pilot Induced Oscillation

19950026065 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
LOW-LEVEL AND NAP-OF-THE-EARTH (NOE) NIGHT OPERATIONS *OPERATION DE NUIT A BASSE ALTITUDE ET EN RASE MOTTES*
Jan 1, 1995; 204p; In English; See also 19950026066 through 19950026084
Report No.(s): AGARD-CP-563; ISBN 92-836-0009-6; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

Tactical rotary wing and low-level, fixed wing aircraft operating in high threat areas require improvements in night and adverse weather conditions in order to increase survivability, improve operational performance, and reduce pilot workload. Recent developments and the results of on-going programs suggest that increased automation and optimized integration of sensors, guidance/navigation, control and display systems, and weapons provide approaches to greatly enhanced capability in night operation. The purpose of this symposium is to support the evolutions and envelopment of alternative core structures which will lead to the fielding of effective low-level and N.O.E. night operations systems for fixed and rotary wing aircraft.
Aircraft Configurations; Conferences; Flight Operations; Flight Paths; Flight Plans; Low Altitude; Mission Planning; Nap-Of-The-Earth Navigation; Night; Rotary Wing Aircraft; Warfare

19950026066 Bureau des Systemes d'Armes; **France**
NIGHT ATTACK *L'ATTAQUE DE NUIT*
Dortomb, Claude, Bureau des Systemes d'Armes, France; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 3 p; In French; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

The ability to carry out night strikes is sought by all countries. Limited to current budgetary constraints and performance of optoelectronic sensors, nacelle mounted active infrared night vision binoculars are the answer to this need. From the simplest to the most complex systems, these can be developed at reasonable costs for in-service aircraft.
Transl. by CASI
Infrared Imagery; Infrared Tracking; Nap-Of-The-Earth Navigation; Night; Night Vision; Optical Tracking; Reconnaissance; Warfare

19950026067 Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan, Italy
AN APPROACH TO SENSOR DATA FUSION FOR FLYING AND LANDING AID PURPOSE
Balzarotti, G., Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; Fiori, L., Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; Midollini, B., Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; Viglialoro, G., Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 8 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Modern aircraft, operating in hostile environments, at night and in adverse weather conditions, are usually equipped with a number of sensors, both active and passive, which separately provide the pilot with data and images and represent a substantial aid during the mission. Novel techniques are currently under development to further improve the effectiveness of the mission by integrating and interpreting the produced data before making them available to the pilot. This paper analyzes the data fusion following a growing integration level criteria. The levels in the integration flow where the fusion is effectively applicable are investigated starting from raw signal (lowest level) up to processed data from sensors, even located on different sites

(highest level). Schematically the integration levels considered in the paper will be the following: (1) sensor/pre-processing; (2) processing; (3) display; (4) operative modes; and (5) multiple platforms.
Derived from text
Display Devices; Landing Aids; Multisensor Fusion; Navigation Aids; Navigation Instruments; Night

19950026078 Eltro G.m.b.H., Heidelberg, Germany
LASER BASED OBSTACLE WARNING SENSORS FOR HELICOPTERS
Buechtemann, W., Eltro G.m.b.H., Germany; Eibert, M., Dornier Luftfahrt G.m.b.H., Germany; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 8 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Helicopters and aircraft in low-level flight have a high risk to strike obstacles, in particular power lines and overhead wires down to the size of telephone wires. This risk increases when flying nap-of-the-earth (N.O.E.), at night and under poor visibility conditions. Existing night vision equipment cannot provide safe detection of these dangerous obstacles. For these reasons there has been, for quite some time, a widely accepted need for reliable means of detecting obstacles, particularly under all acceptable Low-Level and N.O.E. flying conditions. Solutions to this problem, proposed and developed in the past, have been mainly based on millimeter wave technology. More recently, laser based system are being developed which offer good capabilities to solve this task without many of the shortcomings of the radar systems. The laser radar solution, on the other hand, has to prove its adequacy under limited visibility conditions. This paper presents laser radar developments in the thermal infrared (10 micron region) and near infrared spectral regions for helicopter obstacle warning systems. Both Dornier and Eltro have designed, built and demonstrated laser radar sensors for obstacle warning. Eltro has designed and built an experimental laser radar based on CO2-lasers and heterodyne detection. Ranges in excess of 600 m against railway overhead wires and 1100 m against extended targets have been achieved. Dornier has designed, built and flight demonstrated a GaAs laser obstacle warning sensor operating at 0.9 micron. Merits and limitations of these technologies are being discussed.
Derived from text
Carbon Dioxide Lasers; Collision Avoidance; Gallium Arsenides; Heterodyning; Nap-Of-The-Earth Navigation; Navigation Aids; Night Vision; Optical Radar; Radar Detection; Remote Sensing; Warning Systems

19950026079 Army Night Vision Lab., Fort Belvoir, VA, United States
DEVELOPMENT AND FLIGHT TESTING OF AN OBSTACLE AVOIDANCE SYSTEM FOR US ARMY HELICOPTERS
Holder, Sandra L., Army Night Vision Lab., USA; Branigan, Robert G., Army Night Vision Lab., USA; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Today's Army Aviator must fly both low and fast in order to survive against modern anti-aircraft weapons. Such flight brings him perilously close to wires, poles, trees and other obstacles. Helicopter collisions with such obstacles have been a long-standing concern for the USA Army. In order to address this issue, the Night Vision and Electronic Sensors Directorate (NVESD) has sponsored the development of an Obstacle Avoidance System (OASYS) capable of being integrated onto an aircraft and operated in real time. Under this program, two different systems have been fabricated and delivered. Both systems utilize direct detection laser radar sensors which operate in the eyesafe regime. The two systems differ primarily in the type of laser source used. The first system, developed by Northrop Corporation, utilizes a diode laser operating at 850 nm with an average repetition rate of 64 kHz. The second system, developed by Fibertek Inc., utilizes a diode-pumped solid-state laser operating at 1.54 microns with a repetition rate of 15 kHz. Both systems have been integrated onto helicopters and extensive flight evaluations have been completed. A number of important lessons have been learned regarding the individual technologies involved and obstacle avoidance as a whole. Both systems have been demonstrated to enhance mission effectiveness and flight safety. Furthermore, the technologies have been shown to be mature enough to justify proceeding to an Engineering and Manufacturing Development (EMD) phase in which issues relating to cost, volume and weight are addressed.
Derived from text
Architecture (Computers); Computer Systems Design; Flight Tests; Helicopters; Holography; Image Processing; Laser Guidance; Obstacle Avoidance; Optical Radar; Product Development; Solid State Lasers

19960023130 Royal Air Force, High Wycombe, United Kingdom
THE FLIGHT SAFETY OFFICER'S PERSPECTIVE
Spiller, N. B., Royal Air Force, UK; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 23-1 - 23-8; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

RAF aircraft accidents in the last 2 years have included a Hercules in Scotland, where all 9 on board were killed, 2 Harriers, one on operations over Iraq and one on a training flight in England, and a Tornado F-3 and its crew off Cyprus. The RAF also suffered 2 mid-air collision accidents, one involving a Tornado GR-1 and a civilian helicopter and the other 2 Tornados in formadon over Canada. Human factors and the maintenance of situational awareness were a feature in all these accidents. This paper attempts to identify some of the human factors linking these accidents.
Author
Aircraft Accidents; Human Factors Engineering; Midair Collisions; Helicopters; Flight Safety

19960025214 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel., Neuilly-Sur-Seine, France
AIRCRAFT DISINSECTION: A GUIDE FOR MILITARY & CIVILIAN AIR CARRIERS *DESINSECTISATION DES AERONEFS: UN GUIDE A L'INTENTION DES RESPONSABLES DES TRANSPORTS AERIENS CIVILS ET MILITAIRES*
Ellis, R. A., Advisory Group for Aerospace Research and Development, France; Apr. 1996; 84p; In English
Report No.(s): AGARD-AG-340; ISBN 92-836-1036-9; Copyright Waived; Avail: CASI; A05, Hardcopy; A01, Microfiche

Aircraft disinsection is an important tool in preventing the introduction of unwanted pests into a country when an aircraft is returning to its home base. To prevent risks to air crew health, aircraft safety, and industry, Canada's Department of National Defence (DND) has reviewed the importance of aircraft disinsection and the potential problems associated with execution. Over the past two decades, various directives for air crew maintenance personnel, and preventive medicine technicians have been developed and updated periodically. This aircraft disinsection review is part of the latest effort to revise DND's administrative orders on aircraft disinsection. Existing Canadian and foreign legislation, regulations, and recommendations dealing with aircraft disinsection were reviewed. This review also summarises the information that was gathered from various officials involved in the regulation of introduced pests, pesticide registration, and safe pesticide use. Aircraft disinsection technology has evolved over the years since its inception. Practical, up-to-date information on current technologies was gathered, through numerous meetings and correspondence, from researchers, private companies involved in aircraft disinsection, air force personnel, and representatives of civilian air carriers who are active worldwide. The end-result was the development of a current, standard operating procedure for disinsection of Canadian Air Force aircraft in the form of an Air Command Administrative Order. It may serve as a model for the Air Forces and air carriers of other NATO countries.
Author
Military Aircraft; Decontamination; Commercial Aircraft; Insects; Aircraft Maintenance; Regulations

19970014099 Deutsche Flugsicherung G.m.b.H., Offenbach am Main, Germany
AIR TRAFFIC CONTROL PROCEDURES FOR THE AVOIDANCE OF WAKE VORTEX ENCOUNTERS: TODAY AND FUTURE DEVELOPMENTS BY DEUTSCHE FLUGSICHERUNG GMBH
Brenner, Frank, Deutsche Flugsicherung G.m.b.H., Germany; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 14p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

An increasing number of movements of flights leads to the necessity to space aircraft more and more often with the minimum values in order to avoid delays in air traffic. The question is: What are the minimum values? Are the minima established a long time ago by ICAO still valid? On the one hand trials have shown that these values need not necessarily to be obtained if special conditions prevail and the pilot of a succeeding aircraft is able and willing to adjust his flight path in such a way that the safety of the aircraft is not endangered by wake vortices produced by the preceding aircraft. This means the pilots and the air traffic controllers need to understand the behavior of wake vortices and closely cooperate in achieving a high throughput of traffic whilst minimizing the risk of wake vortices encounters.
Derived from text
Air Traffic Control; Wakes; Vortices; Air Traffic; Safety; Collision Avoidance; Warning Systems

19970014100 Deutsche Aerospace A.G., Bremen, Germany
STRUCTURE OF A TRANSPORT AIRCRAFT-TYPE NEAR FIELD WAKE
Huenecke, Klaus, Deutsche Aerospace A.G., Germany; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 10p; In English; See also 19970014096; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The wake issue has widespread concern to commerical aviation because of its hazardous effects on flight safety, and as a limiting factor to increase airport capacity and aircraft efficiency. Results reveal the structure of a near field wake to be of complex nature, even though only the steady-state sector of flow was accessible with available testing gear. Flowfield evaluation focused on: vortex relative motion; streamwise vortex development; crossflow velocity structure; streamwise velocity structure; total pressure loss; and streamwise vorticity redistribution.
Derived from text
Transport Aircraft; Wakes; Vortices; Cross Flow

19970014116 Scientific and Engineering Solutions, Inc., Orleans, MA United States
ANALYSIS OF UK ENCOUNTERS 1982-1990
Burnham, D. C., Scientific and Engineering Solutions, Inc., USA; Nov. 1996; 4p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Wake vortex separation standards are used to limit the frequency and severity of wake vortex encounters under instrument flight rules (IFR). One of the goals of wake vortex research is to develop models that can specify the safe separation for any aircraft pair and hence can be used to judge the safety of proposed changes in separation standards. A direct approach to defining a safe separation model is presented in this paper. The observed UK vortex encounter rates are fitted to a model that defines equal-encounter-rate (EER) separations as a function of the parameters of the leading and following aircraft (specifically their wingspans). Safety is specified by defining the acceptable encounter rate. The first analysis fits the EER separation to powers of the wingspans of the leading and following aircraft. When these powers (1.13 and -0.95, respectively) are found to be close to one, the analysis is repeated using the leader-follower span ratio.
Author
Vortices; Aircraft Wakes

19970026154 Westland Helicopters Ltd., Yeovil, United Kingdom
STORE SEPARATION
McBeath, J. R. B., Westland Helicopters Ltd., UK; Jul. 1997; 20p; In English; See also 19970026150; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The safe separation of a store from any aircraft represents potentially the most hazardous phase of the store release process. The paper examines in turn the various mechanical and aerodynamic influences that come into play during store separation, reviews the requirements imposed by national standards, and explores how modeling and instrumentation techniques have advanced to benefit programs that include verification of safe store separation.
Derived from text
Helicopters; Military Helicopters; Rotary Wing Aircraft; External Store Separation; Flight Characteristics

19970026388 Defence Research Agency, Systems Integration Dept., Farnborough, United Kingdom
AUDIO WARNINGS FOR MILITARY AIRCRAFT
James, S. H., Defence Research Agency, UK; Jun. 1997; 20p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A survey of warning systems currently installed in military aircraft showed that generally they are of poor design. Simply constructed warning sounds have been added to aircraft as and when deemed necessary and hence, have been installed on an individual basis rather than as an integrated warning set. As more and more of these types of sounds are introduced discrimination will become more difficult and confusions increase. Additionally, the warnings are continuous in nature and presented at too high a volume which not only causes startle but interferes with communications, resulting in aircrew seeking the audio mute rather than dealing with the problem at hand. Consequently, the audio warnings currently in use may prove counterproductive and have flight safety implications. This paper details the research conducted by DRA aimed at providing the UK military aircraft fleet with a standardised, fully integrated audio warning suite. to date the work has culminated in the development of a set of design guidelines and a presentation strategy that not only minimizes the number of warning sounds required in a warning set but that remains flexible to allow new warnings to be added without necessarily increasing the number of sounds required. The characteristics for trend indicating sounds are also defined and a protocol for their design detailed. Additionally, in an attempt to enhance the number of audio alerts aircrew can process, manage and respond to accurately, the feasibility of mapping aircraft threat related warnings in three dimensional space is discussed and future research areas detailed.
Author
Warning Systems; Flight Crews; Workloads (Psychophysiology); Audio Equipment; Auditory Perception; Auditory Signals

19970026389 MRC Applied Psychology Unit, Cambridge, United Kingdom
EXTENDING THE FREQUENCY RANGE OF EXISTING AUDITORY WARNINGS
Patterson, R. D., MRC Applied Psychology Unit, UK; Datta, A. J., MRC Applied Psychology Unit, UK; Jun. 1997; 8p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper discusses two projects involving auditory warnings in military helicopters and fixed-wing aircraft. The first project reports methods to increase the frequency range of the existing DRA auditory warnings without changing their sound quality. The need to extend the frequency range arose from the requirement for 'out-of-head' localization of warning sounds. In the second project, the purpose was to develop a new class of sounds to be used as threat warnings. The aim was to make threat warnings that had a distinct sound quality as a set but which were, at the same time, separately identifiable.
Author
Warning Systems; Audio Frequencies; Auditory Perception; Frequency Ranges; Military Helicopters; Fixed Wings; Sound Localization

19970034906 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
AIRCRAFT FIRE SAFETY *LA SECURITE INCENDIE DES AERONEFS*
Sep. 1997; 340p; In English; In French; 88th, 14-17 Oct. 1996, Dresden, Germany; See also 19970034907 through 19970034937; Original contains color illustrations
Report No.(s): AGARD-CP-587; ISBN 92-836-0046-0; Copyright Waived; Avail: CASI; A15, Hardcopy; A03, Microfiche

The Propulsion and Energetics Panel Symposium on Aircraft Fire Safety was held in Dresden, Germany from 14-17 October 1996. It dealt with military and civil aspects of fire safety, covering combat-induced damage and technical sources of fire, fire prevention, fire fighting, fire damage control, and fire damage to humans and equipment. Environmental issues including Halon replacement were addressed. There were 7 sessions (37 papers) and a keynote address: Aircraft Fire Safety; Fires and Fire Handling; On-board Fire

Extinguishing Systems; Certification and Testing; Materials and Structure Design for Fire Safety; Aeromedical Aspects Including Smoke Toxicity; and Passenger Protection and Behaviour.
Author
Aircraft Safety; Fire Damage; Conferences; Passenger Aircraft; Military Aircraft; Fire Prevention; Fires; Halogen Compounds; Aerospace Medicine; Structural Design; Passengers

19970034907 McDonnell-Douglas Corp., Saint Louis, MO United States
FIRE SAFETY AND FIRE PROTECTION FOR MILITARY TRANSPORT AIRCRAFT AS ADDRESSED IN A RECENT NATO/AGARD SURVIVABILITY STUDY
Schwartz, Eric R., McDonnell-Douglas Corp., USA; Park, Shawn, McDonnell-Douglas Corp., USA; Aircraft Fire Safety; Sep. 1997; 12p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper presents the major findings and conclusions related to fire safety and fire protection for military transport aircraft as determined by a recent NATO AGARD study. This study, entitled Enhancing the Survivability of Military Transport Aircraft, addressed all aspects of aircraft design for survivability including both susceptibility and vulnerability reduction techniques. However, in this paper we will focus only on those findings which relate to fire safety and protection. The AGARD study looked at the survivability of military transport aircraft during humanitarian and peacekeeping operations, such as encountered in Panama, Somalia, and the former Yugoslavian states. Typically, transport aircraft are not designed to fly into hostile areas and thus have little protection against ground and air threats. However, with changing political policies and military doctrine, NATO countries have been increasing the utilization of military transports in these potentially hostile roles. The AGARD study focused mainly on potential survivability enhancement retrofits for the current NATO tactical airlifters, the C-130, C-160, and G-222. However, survivability design features were also considered for potential new military transport aircraft such as the European Future Large Aircraft (FLA) and the conceptual USA (U.S.) Advanced Tactical Transport (ATT). This study considered both aircraft susceptibility (inability to avoid being hit by a threat) as well as aircraft vulnerability (inability to avoid damage if hit). The main threats that were considered included; small arms (7.62 mm), high caliber projectiles (12.7 and 23 mm) and hand-held infrared missiles. Larger threats were also considered, but transport survivability against these were mainly dependent on avoidance and susceptibility reduction. Against the smaller threats, several vulnerability shortfalls in the area of fire protection were noted for the C-130, C-160, and G222. The main shortfalls related to fire included; in-tank fire/explosion, void space fire/explosion, exterior fire, and hydraulic fluid fire. Engine fire was not considered a survivability problem since all aircraft in the study had adequate engine fire detection and suppression systems. Many potential solutions were considered to reduce the risk of fire and explosion in order to enhance aircraft survivability. Both passive and active solutions were reviewed, including those used with other military aircraft, and the latest technology being used on the U.S. C-17 and V-22 transport aircraft. Solutions considered included; selfsealing fuel tanks and fuel lines, fuel tank ullage inerting, fuel tank foam (rigid open cell type), dry bay foam (closed cell type), and fire extinguishing systems. The potential solutions were evaluated for ease of retrofit, applicability for new designs, operational restrictions, support requirements, weight, and cost. The major recommendations for retrofit on current aircraft included; fuel tank and dry bay foam, as well as fire extinguishing systems. The major recommendations for consideration in new designs included; fuel tank and fuel line designs to minimize vulnerable areas, self-sealing fuel tanks and fuel lines, fuel tank ullage inerting using onboard inert gas generation (OBIGGS), dry bay inerting, and fire extinguishing systems.
Author
Aircraft Design; Aircraft Survivability; Fire Prevention; Transport Aircraft; Vulnerability; Aircraft Safety; Safety Factors; Warning Systems; Military Aircraft

19970034908 Cranfield Univ., Aviation Safety Centre, Bedford, United Kingdom
A REVIEW OF FIRE RELATED ACCIDENTS, 1985-1995
Taylor, A. Frank, Cranfield Univ., UK; Sep. 1997; 8p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In the 1975 and 1989 AGARD Symposia statistics were presented concerning the survival aspects of transport aircraft accidents. Although much relevant data was still missing it was concluded that not much had changed in the intervening years. Following the Manchester B737 fire accident in 1985 many important recommendations were made and much research has been completed. The current study reviews relevant accidents 'post-Manchester' and tries to assess to what extent the changes that have been made have improved our chances of escaping safely from an aircraft that is on fire or has been damaged sufficiently for fuel to have been spilt. As far as possible criteria identical to those used previously will be employed in order to make the comparisons valid, however it must be appreciated that international aviation is changing and any effects of these changes that can be quantified will also be discussed.
Author
Aircraft Accidents; Transport Aircraft; Fires; Aircraft Safety; Aircraft Survivability; Fire Prevention; Safety Factors

19970034909 Federal Aviation Administration, Fire Safety Sect., Atlantic City, NJ United States
A REVIEW OF RECENT CIVIL AIR TRANSPORT ACCIDENTS/ INCIDENTS AND THEIR FIRE SAFETY IMPLICATIONS
Hill, Richard G., Federal Aviation Administration, USA; Blake, David R., Federal Aviation Administration, USA; Sep. 1997; 6p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper presents a brief summary of recent civil air transport accidents and major incidents involving fire. It updates the paper "Investigation and Characteristics of Major Fire Related Accidents in Civil Air Transports Over the Past Ten Years". A more detailed review of selected accidents/incidents is presented including their link to safety improvements made to-date in fire resistant materials and their impact on improved passenger survivability and the need for improvements in aircraft systems, such as oxygen, hydraulic and electrical, to further improve survivability. Research and Development to reduce aircraft fire fatalities is discussed and justified using accident/incident data. The paper discusses the problem of Halon replacement. Accident/incident data is used to show the need to choose replacement agents that can perform well against real aircraft fires. The need for realistic test methods is discussed. The paper concludes that additional improvements in passenger fire survivability are needed and attainable.
Author
Aircraft Accidents; Civil Aviation; Fires; Transport Aircraft; Fire Damage; Aircraft Safety; Fire Prevention; Commercial Aircraft; Aircraft Survivability; Halogen Compounds

19970034910 Cranfield Univ., Innovation and Technology Assessment Unit, Bedford, United Kingdom
A COMPUTER-BASED SIMULATION AND RISK ASSESSMENT MODEL FOR INVESTIGATION OF AIRLINER FIRE SAFETY
Macey, P., Cranfield Univ., UK; Cordey-Hayes, M., Cranfield Univ., UK; Taylor, A. F., Cranfield Univ., UK; Phillips, W. G. B., Cranfield Univ., UK; Sep. 1997; 12p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A computer simulation model has been developed to investigate fire safety issues in commercial passenger aircraft operations. The aim of the work has been to create a computer-based analysis tool that generates representative aircraft accident scenarios and then simulates their outcome in terms of passenger injuries and fatalities. The details of the accident scenarios are formulated to closely match the type of events that are known to have occurred in aircraft accidents over the last 40 years. This information has been obtained by compiling a database and undertaking detailed analysis of approximately 200 airliner fire accidents. In addition to utilizing historical data, the modeling work has incorporated many of the key findings obtained from experimental research undertaken by the world's air safety community. The unique feature of the simulation process is that all critical aspects of the accident scenario have been analyzed and catered for in the formative stages of the program development. This has enabled complex effects, such as cabin crash disruption, impact trauma injuries, fire spread, smoke incapacitation and passenger evacuation to be simulated in a balanced and integrated manner. The work is intended to further the general appreciation and understanding of the complex events that lead to fatalities in aircraft fire accidents. This is achieved by analyzing all contributory factors that are likely to

arise in real fire accident scenarios and undertaking quantitative risk assessment through the use of novel simulation methods. Future developments will enable the undertaking of a systematic exploration and appraisal of the effectiveness of both current and future aircraft fire safety policies.
Author
Aircraft Accidents; Computerized Simulation; Aircraft Safety; Fires; Commercial Aircraft; Fire Prevention; Passenger Aircraft; Risk; Passengers

19970034911 National Research Council of Canada, National Fire Lab., Ottawa, Ontario Canada
NUMERICAL SIMULATIONS OF AIRCRAFT CABIN FIRE SUPPRESSION
Hadjisophocleous, George, National Research Council of Canada, Canada; Cao, Shu, National Research Council of Canada, Canada; Sep. 1997; 12p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper deals with the modeling, using Computational Fluid Dynamics (CFD) models, of the suppression of aircraft cabin fires using a waterspray system. Combustion was computed using a multi-reaction combustion model and the waterspray trajectories were calculated using a transient Lagrangian model. A fire with a heat release rate of 50 kW was simulated using a pan containing heptane and used to determine the suppression effectiveness of a fine water-spray system. The watersprays were generated using a single nozzle located near the ceiling of the cabin right above the pan. The results showed that, with adequate water mass flow rate, the waterspray system was able to extinguish the assumed fire. With lower mass flow rates, the fire was not extinguished, however, the watersprays were able to cool the hot gases and to maintain survivable conditions in the cabin in terms of temperature. It is important to note, however, that the modeled fire had a fixed area and fire spread was not considered. Allowing the fire to spread to a larger area may result in different extinguishment characteristics. This paper demonstrates that it is possible to use CFD models to simulate the effectiveness of waterspray systems in suppressing aircraft cabin fires. Such models are useful tools to complement real tests and can be used to evaluate the impact of the various parameters on suppression effectiveness and cabin conditions.
Author
Fire Prevention; Computerized Simulation; Aircraft Compartments; Fires; Extinguishing; Water; Spraying; Fire Fighting

19970034912 Greenwich Univ., Fire Safety Engineering Group, London, United Kingdom
USING MATHEMATICAL MODELS TO PREDICT THE DEVELOPMENT OF AIRCRAFT CABIN FIRES
Galea, E. R., Greenwich Univ., UK; Hoffmann, N., Greenwich Univ., UK; Sep. 1997; 12p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Computer based mathematical models describing aircraft fire have a role to play in the design and development of safer aircraft, in the implementation of safer and more rigorous certification criteria and in post mortuum accident investigation. As the cost involved in performing large-scale fire experiments for the next generation 'Ultra High Capacity Aircraft' (UHCA) are expected to be prohibitively high, the development and use of these modeling tools may become essential if these aircraft are to prove a safe and viable reality. By describing the present capabilities and limitations of aircraft fire models, this paper will examine the future development of these models in the areas of large scale applications through parallel computing, combustion modeling and extinguishment modeling.
Author
Aircraft Compartments; Fires; Mathematical Models; Aircraft Safety; Aircraft Design; Parallel Processing (Computers); Combustion; Fire Prevention

19970034913 Civil Aviation Authority, Safety Regulation Group, Gatwick, United Kingdom
POST-CRASH FIRE HAZARDS RESEARCH
Greene, Graham, Civil Aviation Authority, UK; Sep. 1997; 4p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

This paper outlines research funded by the Civil Aviation Authority (CAA) in the UK to explore potential health hazards at aircraft accident sites in the immediate post-crash situation i.e. after rescue and fire fighting has taken place. An initial study considered general hazards, which was followed by work exploring specific problems of composite materials. The intention was to be able to give best advice to personnel who need to be at an accident site, primarily civil authorities, aerodrome staff and accident investigators. There was also expected to be useful information for fire fighters, although they tend to be generally well protected through the nature of their tasks and do receive regular training in the management of hazards. The potential environmental impact of an accident would also be better understood. Many of the hazards are materials with known characteristics although use (quantities and locations) on aircraft may not be readily determined. Composite materials have less understood post-fire hazards although work to date indicates that current CAA advised precautions are adequate, although further work remains before a definitive position may be established. Although the research was funded by CAA, considerable help and advice has been given by the Air Accident Investigation Branch and the Royal Air Force.
Author
Civil Aviation; Fires; Composite Materials; Aircraft Accidents; Fire Prevention; Rescue Operations; Accident Prevention; Safety Factors

19970034914 Royal Air Force, Logistics Command, Huntingdon, United Kingdom
AIRCRAFT POST CRASH MANAGEMENT: THE ROYAL AIR FORCE APPROACH
Andrews, J. W. T., Royal Air Force, UK; Sep. 1997; 6p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Royal Air Force has the responsibility for the recovery and transportation of crashed or disabled British military fixed wing aircraft - worldwide - and this responsibility is discharged by the Aircraft Recovery & Transportation Flight (AR&TF) at RAF St Athan in South Wales. The corresponding responsibility for the recovery of rotary-wing aircraft rests with the Royal Navy. Up to the end of 1990, "the nearest flying unit" had a major responsibility for dealing with aircraft crash recovery and we had no specific concerns about health hazards at aircraft crash sites, however, the crash of a Harrier GR5 in October 1990 completely altered our perceptions and approach to what is now almost universally referred to as Post Crash Management (PCM).
Author
Aircraft Accidents; Harrier Aircraft; Crashes; Health; Rescue Operations; Hazards; Fires; Aircraft Safety; Safety Devices

19970034915 Kidde-Deugra, Gesellschaft fuer Brandschutzsystemembtt, Ratingen, Germany
FIRE SAFETY CONCEPT FOR A MODERN COMBAT AIRCRAFT
Manthey, Christian, Kidde-Deugra, Germany; Sep. 1997; 6p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Engine auxiliary power unit fire detection and extinguishing systems are now standard equipment on modern aircraft and have been installed for many years. The majority of these utilize continuous thermal detection systems which will respond to changes in temperature within the protected compartment. More recently the latest generation combat aircraft have used optical detection systems in place of these traditional thermal detection methods. This offers weight saving and much faster response to fire. Protection of other areas, such as fuel tanks and dry bays, is fast becoming essential as the combat threat from even small arms projectiles increase. It is fundamental to the operational role of combat aircraft that they are exposed to high levels of risk, particularly that resulting from hostile action. A wide range of countermeasures can be, and are, taken to minimize the probability of an aggressor succeeding in damaging the aircraft, but these measures cannot be totally successful and the consequences of sustaining damage must be considered. Studies have been carried out to determine which areas of the aircraft are most susceptible to combat threats and which areas or systems are most likely to cause aircraft damage or loss from fire and explosion if combat damage was sustained. The fuselage, tail and wing were not surprisingly, the areas which suffered the most combat hits contributing to more than 70% of

incidents. Fuel and hydraulic systems were involved in almost 80% of combat losses in fighter aircraft and similar figures were reported for transport aircraft.
Derived from text
Fighter Aircraft; Fire Prevention; Fuel Systems; Optical Measurement; Transport Aircraft; Aircraft Structures; Fires; Warning Systems; Explosions; Safety Devices

19970034916 Federal Aviation Administration, Fire Safety Sect., Atlantic City, NJ United States
WATER SPRAY SYSTEM DEVELOPMENT AND EVALUATION FOR ENHANCED POSTCRASH FIRE SURVIVABILITY AND IN-FLIGHT PROTECTION IN CARGO COMPARTMENTS
Marker, Timothy R., Federal Aviation Administration, USA; Sarkos, Constantine P., Federal Aviation Administration, USA; Hill, Richard G., Federal Aviation Administration, USA; Sep. 1997; 12p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes full-scale fire tests conducted by the Federal Aviation Administration (FAA) to evaluate and optimize water spray systems in two specific aircraft fire safety applications. The first application was an onboard cabin water spray system designed to improve postcrash fire survivability. The goal is to suppress a severe cabin fire, initiated by a large external fuel fire, in order to improve the available time for passenger evacuation. The second application was a cargo compartment water spray system for the purpose of suppressing and controlling in-flight cargo/luggage fires. In this case, the water spray system must suppress and contain a worst-case, deep-seated fire for as long as 180 minutes, or until an airplane can be safely landed.
Author
Aircraft Safety; Fires; Fire Extinguishers; Cargo Aircraft; Passenger Aircraft; Water; Sprayers; Safety Factors; Systems Engineering

19970034917 Solvay Fluor und Derivate G.m.b.H., Hanover, Germany
SYNTHESIS AND PROPERTIES OF VARIOUS ALTERNATIVE FIRE EXTINGUISHING AGENTS
Rudolph, W., Solvay Fluor und Derivate G.m.b.H., Germany; Rieland, M., Solvay Fluor und Derivate G.m.b.H., Germany; Sep. 1997; 6p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The two bromine based fire extinguishing agents, HALON 1211 (CF2ClBr) and HALON 1301 (CF3Br), are extremely effective at extinguishing major conflagrations. Particularly they offer a reliable way of combating fuel, solvent and gas fires. However, these agents are also characterized by a high Ozone Depletion Potential (ODP) and this is the reason why their production has been almost entirely phased out in those countries that have ratified the Montreal Protocol. The paper discusses the synthesis and properties of various alternative fire extinguishing agents and choose best candidates as an alternative for the old HALONs.
Derived from text
Fire Extinguishers; Synthesis (Chemistry); Extinguishing; Replacing; Chemical Properties

19970034918 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, Germany
EXTINGUISHING OF AIRCRAFT INTERIOR FIRES WITH HALON REPLACEMENTS FOR HANDHELD EXTINGUISHERS
Kallergis, K. M., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Sep. 1997; 10p; In English; See also 19970034906; Original contains color illustration; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Because the halons have to be abandoned in the near future the effectiveness of possible replacements for attacking initial fires in civil aircrafts must be investigated. This lecture reports on fire extinguishing experiments with handheld extinguishers on aircraft carpet and seats. Three so-called halon alternatives were compared to the Halon 1211, which is still in use in aviation. to set the aircraft interior on fire for experimental purposes, gasoline was used as fire accelerator which is thought to be realistic in a terroristic attack versus an aircraft. Furthermore, a small-scale hidden fire mock-up is presented. Employing this mock-up the extinguishing qualities of new extinguishing agents can be estimated by laboratory means.
Author
Aircraft Compartments; Alternatives; Fire Extinguishers; Fires; Extinguishing; Aircraft Safety; Fire Prevention; Performance Tests

19970034919 Civil Aviation Authority, Safety Regulation Group, Gatwick, United Kingdom
HALON REPLACEMENT: AVIATION TEST CRITERIA
Povey, Nick J., Civil Aviation Authority, UK; Sep. 1997; 10p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Halon is widely used in civil aircraft. In a typical wide body jet aircraft passengers will be protected by both Halon 1301 and Halon 1211. Over the past 30 years, because of its exceptional fire fighting performance, relative low cost, ready availability and low weight and volume to effectiveness, Halon 1301 has evolved as the agent of choice. A vast amount of testing has been done during that period to certificate Halon fire suppression systems in engine nacelles, auxiliary power unit compartments, trash containers, and cargo compartments of various size and shape. In addition, Halon 1211 in hand held extinguishers has been found to be very effective in fighting the most hazardous of in-flight fires. This paper discusses the minimum performance criteria for replacement hand held portable extinguishers for aircraft cabin fire protection.
Derived from text
Aircraft Compartments; Civil Aviation; Fire Extinguishers; Fire Prevention; Alternatives; Performance Tests; Fires

19970034920 Federal Aviation Administration, Fire Safety Sect., Atlantic City, NJ United States
DESCRIPTION AND STATUS OF CIVIL AVIATION'S HALON REPLACEMENT PROGRAM
Hill, Richard G., Federal Aviation Administration, USA; Sarkos, Constantine P., Federal Aviation Administration, USA; Sep. 1997; 6p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Civil aviation has a major program to replace halons with environmentally acceptable agents/systems in transport aircraft fire extinguishing systems. The program is international in participation and is harmonized amongst the regulatory authorities in the U.S., Europe and Canada. An International Halon Replacement Working Group provides for frequent review and critique of progress, task group studies of issues that arise and planning of technical test activities. The program emphasizes full-scale fire tests to evaluate the effectiveness of replacement/alternative agents and to develop certification criteria for those agents that are equivalent to halon in firefighting effectiveness and are compatible with operational requirements. This will ensure that the current level of fire safety will continue to be maintained in future aircraft fire extinguishing systems.
Author
Fire Extinguishers; Aircraft Safety; Transport Aircraft; Fire Prevention; Alternatives; Performance Tests; Aircraft Compartments

19970034921 Faverdale Technology Centre, Darlington, United Kingdom
PERFORMANCE OF FIRE FIGHTING POWDERS
Brogan, E., Faverdale Technology Centre, UK; Sep. 1997; 6p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A series of dry powder fire extinguishing tests have been carried out by Faverdale Technology Centre for the Civil Aviation Authority's Safety Regulation Group. The aim of the test programme was to design a test specific to those aviation fuel fires which are not covered by normal class 'B' fire testing. It would then be possible to assess objectively the performance of dry powders for aviation uses. A specially designed test rig on which the fire tests would be carried out was designed and developed to model a running fuel fire and spray fire. The test method involved the manual application of the dry powder by personnel trained in the art of firefighting. The test programme was split into three phases: Phase A - set out to determine the suitability of Monnex(R) dry powder as a benchmark for future tests by extinguishing fires of Jet A1 aviation fuel within a 0.66 sq m pool tray. Phase B - concentrated upon small scale testing on a 2.8 sq m pool tray, using Monnex(R) and a standard powder. Phase C - comprised of an inves-

tigation into the optimum mass of dry powder required to extinguish two different full scale fire test scenarios; that is a cascade fire and the spray fire. Three different types of dry powder were employed, one Monnex(R) and two standard powders. All the tests were instrumented with metal sheathed thermocouples and heat flux meters to monitor the fire characteristics of temperature and radiant and convective heat flux respectively. The fire test methods used are described and the performance of the dry powders are presented in this paper. The results from the Monnex(R) tests are compared with the results from the standard powder tests. Particular attention was paid to the mass of powder required to extinguish each test fire. Although two different standard powders were used, only one of these was particularly suited to class B fires, hence the performance of this other powder was seen to be totally ineffective against any of the fuel fires it was tested on. The other standard powder was suitable for class B fires and the average mass used to extinguish the spray and cascade fires was more than the average mass of Monnex(R) required for the same fires. In summary Monnex(R) used less powder to extinguish the Phase B and C fires and was therefore considered to be a suitable agent to be used as a benchmark for further tests. This work is not conclusive and current investigations are studying the effect of application discharge rate of Monnex(R). Once these studies show the optimum application rate of Monnex(R), work to compare with other dry powders will resume.
Author
Aircraft Fuels; Aircraft Safety; Fire Extinguishers; Powder (Particles); Extinguishing; Fires; Performance Tests

19970034922 Instituto Nacional de Tecnica Aeroespacial, Madrid, Spain
INTERIOR CONDITIONING IN MILITARY TRANSPORT: AIRCRAFT CERTIFICATION
Perona, Enrique Nin, Instituto Nacional de Tecnica Aeroespacial, Spain; Balaguer, Bartolome Marques, Instituto Nacional de Tecnica Aeroespacial, Spain; Sep. 1997; 8p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This conference gives an overall vision of the task to be carried out regarding the Interior Conditioning System of a Military Transport Aircraft in order to obtain its Type Certificate. The following will be analyzed in more detail: assessment of the certification requirements, and their fulfillment, applicable standards, test facilities and associated problems; and subsequent modifications after obtaining the design type with technical evaluation of the modification and its impact on airworthiness.
Author
Certification; Military Aircraft; Aircraft Compartments; Transport Aircraft

19970034923 Societe Nationale d'Etudes et de Construction de Moteurs Aeronautiques, Moissy-Cramayel, France
PROGRESS IN FIRE HOLDING TESTS OF REACTOR AND NACELLE COMPONENTS *PROGRES DANS LES ESSAIS DE TENUE AU FEU DES COMPOSANTS DE REACTEUR ET NACELLE*
Derouet, P. R., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Picart, J. Y., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Sep. 1997; 18p; In French; See also 19970034906; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The demonstration of fire performance of reactor components and cockpits (of a airplane) often requires one to carry out tests in the presence of a flame generated by a burner. During the 1950s, standardization documents were established, and associated testing devices (burners) were the focus, mainly to verify the fire performance of fuel oil piping systems and operation of fire detection devices. More recently, the more frequently common use of these devices to demonstrate fire performance of quite different equipment and components installed on engines and cockpits of modern airplanes has demonstrated certain shortcomings pertaining to standards as well as existing burners. The goal of the publication is to reveal the work conducted by SNECMA, in association with official French departments (STPA) and the propulsion test center (CEPr) to improve exiting materials, to simplify their use, and especially to make them equivalent, especially propane and fuel oil burners. The study also presents analysis devices which have been developed and used at Snecma in combination with the tests.
Transl. by Schreiber
Aircraft Safety; Fires; Performance Tests; Fire Prevention; Nacelles; Standardization; Fire Extinguishers; Propulsion

19970034924 Purdue Univ., West Lafayette, IN United States
THERMAL AND MECHANICAL LOADING ON A FIRE PROTECTION SHIELD DUE TO A COMBUSTOR BURN-THROUGH
Messersmith, N. L., Purdue Univ., USA; Murthy, S. N. B., Purdue Univ., USA; Sep. 1997; 14p; In English; See also 19970034906
Contract(s)/Grant(s): FAA-92-G-0024; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A combustor burn-through can give rise to an under-expanded, sonic or supersonic jet of gases and flames out of the combustor. The pressure and temperature in the jet may be as high as the highest values of pressure and temperature arising in the combustor. In order to protect the engine and aircraft components from exposure to the jet over a period of time, a fire shield is installed adjoining the combustor. The USA Federal Aviation Administration has issued an Advisory Circular 20-135 redefining the requirements on the fire protection shield, and the overall objective of the project was to establish the basis for a preliminary design of a test facility and testing procedure for such fire shield materials. The current study was devoted to the determination of the mechanical and thermal loads that arise on the shield due to the impact of hot, high pressure, high speed jets. The results obtained assist in the identification of some of the essential features required in a test facility, and the test plans and procedures.
Author
Combustion Chambers; Engine Parts; Fire Prevention; Fires; Gas Jets; Structural Failure; Thermal Fatigue; Aircraft Safety; Accident Prevention

19970034925 Daimler-Benz Aerospace A.G., Military Aircraft Div., Munich, Germany
STRUCTURAL DESIGN CONSIDERATIONS FOR AIRCRAFT FIRE SAFETY
Voglsinger, M., Daimler-Benz Aerospace A.G., Germany; Lang, R., Daimler-Benz Aerospace A.G., Germany; Guenther, G., Daimler-Benz Aerospace A.G., Germany; Woerdehoff, J., Daimler-Benz Aerospace A.G., Germany; Sep. 1997; 12p; In English; See also 19970034906; Original contains color illustration; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Fire cannot be completely prevented by design and material means, in particular those caused by armor piercing munitions. Structural aims are therefore: (1) to keep the fire within the fire zones, which are designed to withstand fire exposure for a certain time accepting strength degradation; (2) To protect the primary structure, essential for structural integrity. Protection can be provided by separation, sealing, insulation, ventilation (cooling); (3) To select heat resistant materials in these areas accepting mass penalties; to provide redundant load paths, accepting reduced strength capability; (3) to size critical structural elements for limited fire/heat exposure. In case of fire non-destructive and destructive methods to determine the residual strength have limited reliability due to the unknown temperature and time the structure has been exposed to. Temperature-gauge-plates in the fire zones could ease the problem.
Author
Refractory Materials; Residual Strength; Structural Design; Structural Failure; Aircraft Safety; Fires; Fire Fighting; Fire Damage; Aircraft Structures

19970034926 Federal Aviation Administration, Atlantic City, NJ United States
BURNTHROUGH RESISTANCE OF FUSELAGE AND CABIN STRUCTURES
Marker, Timothy R., Federal Aviation Administration, USA; Dodd, Darren C., Faverdale Technology Centre, UK; Povey, Nick J., Civil Aviation Authority, UK; Sep. 1997; 14p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes the joint research project undertaken by the United States Federal Aviation Administration (FAA) and the UK Civil Aviation Authority (CAA) to evaluate and improve upon the fuselage burnthrough resistance of transport category aircraft to large fuel fire

exposure. In an earlier project several surplus transport aircraft were exposed to large area fuel fires. During these tests, the fire entry points, likely fire paths to the cabin, and time frame involved for this to occur were investigated. The current project is an extension of this earlier work. The project is divided into several phases: development of a full scale testing device, development of a medium scale testing device, and follow-on research leading to the potential development of specifications for materials, systems and components which would increase fuselage burnthrough resistance. The CAA tasked Faverdale Technology Centre (FTC) to develop a medium scale test apparatus. FTC completed construction of the testing apparatus in 1993. The FAA had the responsibility of developing a full-scale burnthrough test rig, which was completed in 1995, at the FAA Technical Center in Atlantic City. Several tests have been completed in the full scale test rig. The test results of both the medium and full-scale rigs will be discussed, along with future considerations. In Europe an Industrial consortium led by Airbus Industrie will be proposing an Industrial Materials and Technology research project to the European Commission. This project will build on the work initiated by the Authorities. The objective is to identify materials and processes capable of substantially improving burnthrough resistance and also capable of being introduced to aircraft production lines in a timely and economical manner.
Author
Transport Aircraft; Fuselages; Aircraft Compartments; Aircraft Safety; Fires; Accident Prevention; Aircraft Fuels; Spontaneous Combustion; Performance Tests

19970034927 Daimler-Benz Aerospace A.G., Munich, Germany
TITANIUM FIRE IN JET ENGINES
Uihlein, T., Motoren- und Turbinen-Union G.m.b.H., Germany; Schlegel, H., Motoren- und Turbinen-Union G.m.b.H., Germany; Sep. 1997; 12p; In English; See also 19970034906; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In aero-engines, titanium fire occurs in the fan and compressor where titanium is indispensable because of its high strength-to-weight ratio. Titanium alloys are mainly used for blading, casings and disks. Consequently, if bearing- or blade-failure occurs, the possibility of an uncontained titanium fire cannot be excluded. A titanium fire is a very short event of about 4 to 20 seconds duration depending on the engine design and the operating conditions. It is a violent conflagration accompanied by temperatures as high as 3,300 C. This energy destroys surrounding materials, including steel and nickel alloys, by burning and melting. When this happens, the airframe structure can be severely damaged, even resulting in the loss of the aircraft. Extinguishing the fire is impossible because of its rapid propagation and the very short time between its detection after uncontainment and its termination. Common fire-extinguishing agents are not suitable for quenching a titanium fire because their composition is inadequate and sufficient quantity is not available. But these agents can prevent propagation of the fire in the engine bay. The risk involved can be avoided by such measures as intelligent design, fire-preventive coatings, and use of titanium alloys that are not easily combustible. The development of preventive measures calls for rig tests in order to simulate burning conditions, and to verify the efficacy of the measures. Titanium can then be used safely in advanced technology engines for modern aircraft.
Author
Aircraft Engines; Aircraft Construction Materials; Fires; Flammability; Engine Parts; Titanium Alloys; Fire Prevention; Aircraft Safety; Aircraft Structures

19970034928 Structural Laminates Co., Delft, Netherlands
GLARE(R): A STRUCTURAL MATERIAL FOR FIRE RESISTANT AIRCRAFT FUSELAGES
Roebroeks, G. H. J. J., Structural Laminates Co., Netherlands; Sep. 1997; 14p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

GLARE(R) consists of thin aluminum alloy sheet and fiber layers containing strong unidirectional glass fibers and epoxy adhesive. The material has been optimized to overcome the corrosion and fatigue problems of monolithic aluminum alloys and meets all requirements for use in primary aircraft structures. In 1994 several GLARE grades with biaxial fiber layers were certified to the fire resistance requirements for cargo liners specified in FAR 25.855. The material even resists an 1100 C flame for more than 15 minutes without penetration. The fire resistance of GLARE together with the materials' outstanding impact properties makes GLARE an attractive candidate for future application in cargo liners and floors. The behavior of GLARE in blast-resistant containers providing fire resistance after the blast, proves the materials' capabilities. Due to its material properties GLARE is also attractive for fuselage skin applications. This is one of the few options to have fire resistant fuselages in the near future.
Author
Aircraft Construction Materials; Fuselages; Aluminum Alloys; Metal Sheets; Fiber Composites; Flammability; Fire Prevention; Aircraft Safety

19970034929 Federal Aviation Administration, Fire Research Sect., Atlantic City, NJ United States
NEW FIRE SAFE MATERIAL FOR CABIN INTERIORS
Lyon, Richard E., Federal Aviation Administration, USA; Sorathia, Usman, Naval Surface Warfare Center, USA; Balaguru, P. N., Rutgers - The State Univ., USA; Foden, Andrew, Rutgers - The State Univ., USA; Davidovits, Joseph, Geopolymer Inst., France; Davidovics, Michele, Geopolymer Inst., France; Sep. 1997; 8p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The fire response of a potassium aluminosilicate matrix (GEOPOLYMER) carbon fiber composite was measured and the results compared to organic matrix composites being used or considered for aircraft cabin interior applications. At irradiance levels of 50 kW/sq m typical of the heat flux in a well developed cabin fire, glass- or carbon-fiber reinforced polyester, vinylester, epoxy, bismaleimide, cyanate ester, polyimide, phenolic, and engineering thermoplastic laminates ignited readily and released appreciable heat and smoke, while carbon-fiber reinforced GEOPOLYMER composites did not ignite, burn, or release any smoke even after extended heat flux exposure. The GEOPOLYMER matrix carbon fiber composite retains sixty-three percent of its original flexural strength after a simulated large fire exposure.
Author
Aircraft Compartments; Fiber Composites; Carbon Fibers; Aircraft Construction Materials; Irradiance; Flammability; Fires; Fire Prevention; Laminates; Matrix Materials; Polymers

19970034930 Centre d'Essais Aeronautique Toulouse, France
TOXICITY OF COMBUSTION PRODUCTS IN MATERIALS USED FOR CABIN FIXTURES: A SIMPLIFIED METHOD OF EVALUATION *TOXICITE DES PRODUITS DE COMBUSTION DE MATERIAUX UTILISES DANS L'AMENAGEMENT CABINE: UNE METHODE D'EVALUATION SIMPLIFEE*
Mansuet, A., Centre d'Essais Aeronautique Toulouse, France; Petit, J.-F., Centre d'Essais Aeronautique Toulouse, France; Sep. 1997; 10p; In French; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

During the 73rd AGARD symposium held at SINTRA in 1989, we presented a methodology that combines an original fire model and an experimental protocol that allows one to evaluate the reaction of fire on the materials by physico-chemical criteria and also the toxicity of the combustion products by biological criteria as measured on monkeys. A method of classifying these materials has been proposed. Based on this methodology, the data gathered on 6 cabin fixture materials allow us to demonstrate a relation between the loss of mass, therefore the quantity of material degraded, and the incapacitation time of the animal.
Transl. by Schreiber
Combustion Products; Fires; Toxicity; Fixtures; Aircraft Compartments; Flammability; Aircraft Construction Materials

19970034931 Guys Hospital Medical School, Dept. of Forensic Medicine, London, United Kingdom
CAUSE OF DEATH: FIRE OR TRAUMA?
Hill, Ian R., Guys Hospital Medical School, UK; Sep. 1997; 8p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Differentiating between competing possibilities is often a difficult task. When fire is involved the problems are so much greater because of the combustion of evidence and the capacity for mimicry. It is not unknown for finite answers to evade even the most cautious scrutiny and thus the answers to right and proper questions must, in medico-

legal language, be considered to be unascertained. In an aircraft accident, where much may depend upon the availability of precise information, this capacity for failure is troubling, as indeed it is in many other situations. However, because of the publicity which may accompany a fatal aircraft accident, with demands for changes in design, this is an impediment which causes great concern. Superficially it may seem that there ought not to be any difficulty, but this is to ignore the nature of fires. Moreover, it assumes that there are always clear indications of the cause and manner of death, and that the diagnostic difficulties are entirely a product of a failure to observe the signs. This is clearly not the case, though it has to be acknowledged that if the investigation is lacking, then there may not be enough evidence to make a proper diagnosis. This paper looks at these difficulties and places them in the context of the search for improved flight safety.
Derived from text
Aircraft Accidents; Death; Fires; Flight Safety

19970034932 Army Medical Research Detachment, Wright-Patterson AFB, OH United States
TOXICITY ISSUES IN AIRCRAFT FIRE SCIENCE
Miller, C. R., Army Medical Research Detachment, USA; Sep. 1997; 6p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Many factors must be considered when using experimentally derived toxicity information to predict human response. Two important principles for appropriate use of toxicity data include obtaining information from an appropriate source and applying that information appropriately. Examples from our laboratory research are included, in which bench-scale combustion tests of advanced composite materials were conducted, collecting information such as mass loss rate, particle characteristics, and chemical characteristics of the smoke. Methods we employed in the evaluation of ACM combustion products include: (a) chemical analysis of the vapor and soot, (b) continuous plume temperature recording, (c) continuous monitoring of combustion gases, (d) determination of mass loss rate during combustion, and (e) morphologic evaluation of airborne particulate matter using light and electron microscopy, combined with computer-based image analysis.
Author
Combustion Products; Aircraft Safety; Toxicity; Fires

19980011519 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
ICE ACCRETION SIMULATION *LA SIMULATION DE L'ACCUMULATION DE GLACE*
Dec. 1997; 184p; In English
Report No.(s): AGARD-AR-344; ISBN 92-836-1067-9; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

Ice Accretion Simulation is an important issue for flight safety. Every year several incidents happen which can be associated with severe icing problems. Although the bulk of them may be due to human mistakes during flight in icing conditions, some cases remain which are consequences of icing conditions never observed before or of failures not foreseen. Therefore, icing has always attracted great interest from aircraft manufacturers, authorities responsible for certification, and many researchers. The overall goal of the work presented in this report is to improve reliability, to reduce efforts and costs in civil and military aircraft certification/qualification procedures, and to improve civil and military aircraft flight safety. This report covers the effects of ice accretion on wings, tail surfaces, engine inlets, and rotary wings. Experimentally, besides the capability of icing wind tunnel facilities, the problems of spray tanker aircraft experiments are considered, the related similarity laws are examined, and the techniques for measuring droplet size and distribution are reviewed. The basic factors influencing computational predictions are discussed in detail, especially factors such as surface roughness and surface heat transfer. In addition to the 2D prediction methodology, the status of extensions to 3D is presented. An essential aim of a planned follow-on activity should be to establish some well-documented reference cases by suitable in-flight experiments, and to calibrate prediction tools and experimental facilities and techniques for those reference cases.
Author
Ice Formation; Simulation; Flight Safety; Reliability; Costs; Civil Aviation; Prediction Analysis Techniques; Attack Aircraft

19980021248 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
THE PREVENTION OF AIRCRAFT ACCIDENTS THROUGH THE COLLECTION AND ANALYSIS OF HUMAN FACTOR/AEROMEDICAL AIRCRAFT ACCIDENT DATA *LA PREVENTION DES ACCIDENTS D'AVION PAR LA COLLECTE ET L'ANALYSE DE DONNEES D'ACCIDENTS FACTEURS HUMAINS/AEROMEDICAUX*
Tejada, F., Editor, Centro de Instruccion de Medicina Aeroespatial, Spain; Magnusson, Kent E., Editor, Air Force Systems Command, USA; Cugley, Jennifer, Editor, Royal Air Force, UK; Courchesne, Cyd E., Editor, Canadian Air Command Headquarters, Canada; Alnaes, A., Editor, Oslo Military Clinic, Norway; Knoefel, H. J., Editor, Institute of Aviation Medicine, Germany; Grau, Jean Yves, Editor, Institut de Medicine Aerospatiale Armee, France; Lyons, Terence J., Editor, Air Force Systems Command, USA; Guadalupi, Francesco, Editor, Commissione Sanitaria di Appello A.M., Italy; Feb. 1998; 124p; In English
Report No.(s): AGARD-AR-361; ISBN 92-836-0052-5; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

The overall goal of Working Group 23 was to improve the application of human factors analysis to operational enhancement and mishap prevention programs. Through different chapters, a variety of related topics were discussed in relation to the current status and approaches to aircraft accident/incident investigation, taking into account the human factors involved, procedures, categorization, tabulation and analysis. In addition, following a questionnaire which was widely distributed among all NATO countries, current data concerning the number of accidents, human factors studies, organizational aspects and the data collection were compiled and discussed. Also the possible approaches to conceptual models were described as a potential framework for the support and organisation of the principles and topics to be included in human factors/aeromedical data base. The Working Group reviewed current training programmes and discussed a common approach, in which human factors play a definite role. Examples of data bases currently in use are enclosed.
Author
Aircraft Accidents; Prevention; Human Factors Engineering; Data Acquisition; Education; Aerospace Medicine

19980033537 Defence and Civil Inst. of Environmental Medicine, North York, Ontario Canada
SURVIVING A HELICOPTER DITCHING: AN ENGINEERING CHALLENGE
Brooks, C. J., Defence and Civil Inst. of Environmental Medicine, Canada; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 8p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The audience today is primarily engineers, and the first objective is to convince them that flying a helicopter over water is more dangerous than flying a fixed wing aircraft over water. The evidence for this was first reported in 1984 by the UK Civil Aviation Authority (CAA) in the HARP Report (16). It concluded that the accident rate for helicopters operating over the North Sea was 2.0 per 100,000 flying hours compared to 0.4 for fixed wing aircraft. A subsequent review of accident data by the CAA (17) in 1995 reported that "In the 18 years from 1976 to 1993, the offshore industry has generated 2.2 million helicopter operating hours in the transportation of 38 million passenger for the loss of 85 lives in eight fatal accidents. This represented a fatality rate of 3.86 per 100,000 flying hours."
Derived from text
Helicopters; Aircraft Configurations; Aircraft Accidents; Helicopter Control; Losses; Civil Aviation

19980048995 Centro de Instruccion de Medicina Aeroespatial, Madrid, Spain
INJURY PREVENTION IN AIRCRAFT CRASHES: INVESTIGATIVE TECHNIQUES AND APPLICATIONS: GENERAL CONCEPTS AND OBJECTIVES
RiosTejada, Francisco, Centro de Instruccion de Medicina Aeroespatial, Spain; Injury Prevention in Aircraft Crashes: Investigative Techniques and Applications; Feb. 1998; 8p; In English; See also 19980048994; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Accidents were investigated to reveal any of the wide range of human factors such as underlying illness, use of medications or drugs, fatigue, physical stresses, psychological and psychosocial stresses,

types and extension of injuries received, causes of impact injuries, emergency escape from the aircraft, smoke and fire as related to survivability, environmental conditions and a number of other biomedical conditions that may have contributed to the crash or be related to occupant injury or survival. A detailed analysis of injury sustained in aircraft impact would contribute to an understanding of the mechanisms involved and to know the design limitations of the human body to an impact and its survivability. While many similar injuries can be inflicted in a variety of ways, there are certain characteristic findings which suggest likely mechanisms of injury. For example, compression fractures of vertebral bodies in the low thoracic and lumbar spine typically occur as a consequence of forces acting approximately parallel to the long axis of the spine.
Derived from text
Aircraft Accidents; Aircraft Accident Investigation; Human Factors Engineering; Injuries; Sicknesses; Survival; Prevention; Aircraft Safety

19980201661 Technische Univ., Inst. of Flight Guidance and Control, Brunswick, Germany
CONDUCT OF THE AIRCRAFT: FLIGHT DYNAMICS
Schaenzer, G., Technische Univ., Germany; Dec. 1997; 6p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Safety, production and operation costs have an influence on the design of aircraft flight controllers and thus, as well on the necessary sensors and actuators. Reliability and safety have a dominating role in this design process. Taking these premises into consideration, this paper describes some important aircraft flight control design aspects. Author
Flight Control; Aircraft Control; Control Equipment; Flight Paths; Aircraft Maneuvers

19990014358 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
FUTURE TRANSPORT AIRCRAFT (FTA): TACTICAL TRANSPORT INTERMEDIATE RANGE
Wieland, Klaus, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 35-39; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

The report begins with a general discussion of existing tactical aircraft and a look into the necessary design characteristics of the next generation tactical airlifter. In section 2, the main elements in the development of the future European tactical air lifter are presented. These elements are comprised of: (1) the application of carbon reinforced plastics for the wing primary structure; (2) development of a turboprop engine for cruise speeds up to M=.72; (3) aerodynamic design and propeller/wing integration; (4) application of a modern Electronic Flight Control System (EFCS); and (5) autonomous and silent high precision navigation and landing.
CASI
Transport Aircraft; Turboprop Engines; Aerodynamic Configurations; Flight Control

04
AIRCRAFT COMMUNICATIONS AND NAVIGATION

19950026069 NASA Ames Research Center, Moffett Field, CA, United States
FLIGHT TEST OF A LOW-ALTITUDE HELICOPTER GUIDANCE SYSTEM WITH OBSTACLE AVOIDANCE CAPABILITY
Zelenka, Richard E., NASA Ames Research Center, USA; Clark, Raymond F., Army Command/Control and Systems Integration Directorate, USA; Branigan, Robert G., Army Night Vision Lab., USA; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Military aircraft regularly conduct missions that include low-atltitude, near-terrain flight in order to increase covertness and payload effectiveness. Civilian applications include airborne fire fighting, police surveillance, search and rescue, and helicopter emergency medical service. Several fixed-wing aircraft now employ terrain elevation maps and forward-pointed radars to achieve automated terrain following or terrain avoidance flight. Similar systems specialized to helicopters and their flight regime have not received as much attention. A helicopter guidance system relying on digitized terrain elevation maps has been developed that employs airborne navigation, mission requirements, aircraft performance limits, and radar altimeter returns to generate a valley-seeking, low-altitude trajectory between waypoints. The guidance trajectory is symbolically presented to the pilot on a helmet mounted display. This system has been flight tested to 150 ft (45.7 m) above ground level altitude at 80 kts, and is primarily limited by the ability of the pilot to perform manual detection and avoidance of unmapped hazards. In this study, a wide field of view laser radar sensor has been incorporated into this guidance system to assist the pilot in obstacle detection and avoidance, while expanding the system's operational flight envelope. The results from early flight tests of this system are presented. Low-altitude missions to 100 ft (30.5 m) altitude at 80n kts in the presence of unmapped natural and man-made obstacles were demonstrated while the pilot maintained situational awareness and tracking of the guidance trajectory. Further reductions in altitude are expected with continued flight testing.
Derived from text
Air Navigation; Aircraft Configurations; Flight Tests; Helicopters; Helmet Mounted Displays; Low Altitude; Obstacle Avoidance; Optical Radar; Relief Maps; Terrain Following

19950026710 Central Research and Development Inst. Elektropribor, Saint Petersburg, Russia
NAVIGATIONAL TECHNOLOGY OF DUAL USAGE
Peshekhonov, V. G., Central Research and Development Inst. Elektropribor, Russia; Okon, I. M., Central Research and Development Inst. Elektropribor, Russia; Nesenyuk, L. P., Central Research and Development Inst. Elektropribor, Russia; Belous, Yu. P., Central Research and Development Inst. Elektropribor, Russia; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 6 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Under the new conditions of defense production conversion and basing on high technologies that were developed for the production of military navigation technology the Central R&D Institute 'Elektropribor' has been developing and starts manufacturing products for civil application. Part of the project is dual usage technology. Three trends of the research are considered in this paper: (1) a gimbaled-type inertial system used to inspect railway tracks and in inertial geodesy; (2) gyrostabilized gravity meter for geological prospecting of oil and gas from ships and planes; and (3) shipborne integrated chartgraphic navigation-controlling system.
Derived from text
Gravimeters; Inertial Navigation; Military Technology; Rail Transportation; Technological Forecasting; Technology Transfer; Technology Utilization

19950026713 Technische Univ., Inst. fuer Flugfuehrung., Brunswick, Germany
EFFECTS OF THE SPECIFIC MILITARY ASPECTS OF SATELLITE NAVIGATION ON THE CIVIL USE OF GPS/GLONASS
Kayser, Detlef, Technische Univ., Germany; Schaenzer, Gunther, Technische Univ., Germany; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 10 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Satellite Navigation is one of todays most promising and prospering infrastructure technologies. The performance improvement of this technology in comparison to the 'conventional' terrestrial navigation systems can be seen in almost every aspect, e.g.: (1) accuracy (decimeter level); (2) coverage (worldwide); (3) availability (21 hrs); (4) dimension (4 dimensional navigation (space and time)); and (5) system capacity (unlimited number of users). This led to a widespread application of satellite navigation and an according fast growing figure of satellite navigation equipment in the civil market. Up to now however, the final breakthrough in a lot of commercial applications, like in the aviation industry and in the maritime business, has not been reached. Beside some still unsolved technical aspects, like the integrity problem, the fact that GPS and GLONASS are military systems is one of the main hurdles. This institutional aspect, however, is not only an obstacle from the political point of view, but the military background of GPS/GLONASS led to lot of design features of the system, that have

a strong influence on the use of the system in civil applications. This paper will describe details on the different areas in which the military design limits the use of the system.
Derived from text
Commerce; Global Positioning System; GLONASS; Military Operations; Navigation Aids; Satellite Navigation Systems; Technology Assessment; Technology Transfer

19950026714 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Flight Guidance., Brunswick, Germany
THE DLR RESEARCH PROGRAMME ON AN INTEGRATED MULTI SENSOR SYSTEM FOR SURFACE MOVEMENT GUIDANCE AND CONTROL
Klein, Kurt, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 8 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Based on the long-term experience in the field of Navigation and Air Traffic Control the Institute of Flight Guidance within the German Aerospace Research Establishment (DLR) is conducting a major effort to develop new solutions, system components and procedures for an integrated Surface Movement Guidance and Control System (SMGCS). In addition to and derived from the work on operational procedures, planning tools and HMI in our institute we are focusing our work on an integrated sensor concept to meet the requirements. SMGCS is to be regarded as an integrated concept that has a clearly defined modular approach to meet the particular requirements of a specific aerodrome. After outlining the conception several years ago a solution for the realization was evaluated in close co-operation with the DFS and the national industry. The objective of DLR research is: (1) to analyze the characteristics and to optimize as far as necessary the sensor candidates (e.g. DGPS, SSR Mode S Multilateration); (2) to evaluate the sensor information integration including data fusion algorithms; (3) to find solutions for the specific SMGCS data exchange problems via RF link; (4) to optimize the whole system loop in order to avoid interference by implementing modules into the system; and (5) to solve airfield operating problems by finding new functions within the SMGCS sensor domain. Although the main goal is the improvement of civil airport traffic, the work meets as well military operation problems. In addition, a lot of knowledge gained in military applications has to be considered. The research activities are funded by the DLR itself. to extend the theoretical and laboratory work to more realistic analysis an Experimental SMGCS is build up at the Braunschweig airport. This ESMGCS has the advantage of being very flexible with respect to the implementation of various subsystems and to tests in a real environment. Braunschweig airport is very suitable for experiments like this due to low traffic density and the available research infrastructure. Part of the ESMGCS will be a test environment that is based on the experiences gained during the MLS competition as well as during the development of the Avionics Flight Test System. Main part of the test environment is a measurement system for computing a reference situation assessment. The backbone of the ESMGCS is a high speed data network on fiber cable basis that connects the peripheral stations around the airfield to the master station. Different sensor subsystems or parts of these will be installed in the peripheral stations. The data fusion and the situation analysis are software processes within the master station. The derived situation information can be handed over to planning tools and to the tower simulator available in the DLR Institute of Flight Guidance.
Derived from text
Air Traffic Control; Command and Control; East Germany; Guidance Sensors; Microwave Landing Systems; Military Technology; Multisensor Fusion; Research Projects; Systems Integration; Technology Utilization

19950026715 Centre d'Etudes et de Recherches, Dept. d'etudes et de Recherche en Optique., Toulouse, France
LOW-LEVEL DATA FUSION FOR LANDING RUNWAYS DETECTION
Sliwa, Laure, Centre d'Etudes et de Recherches, France; Briottet, Xavier, Centre d'Etudes et de Recherches, France; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 11 p; In English; See also 19950026705; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

Data fusion brings reliability and robustness to both military and commercial systems. Data fusion allows in fact to fully apprehend a situation by using multisensors data redundancy and/or complementarity. The presented piece of work particularly concerns fusion of redundant data just outcoming from electro-optical sensors. The used methods are low-level fusion techniques, only preceded by a calibration step. These fusion techniques take into account the radiometric- and not geometric-data content. This paper is divided in two parts: the theoretical approach, and the guidance application of detecting a potential runway. The theoretical approach, according to the proposed goal, raises two problems. The one of suiting the multisensors' configuration to the mission. And the one of evaluating data at every step from ground reality to fusion. It appears necessary to define quality criteria to evaluate every sensor acquisition within the mission scope. The optimization of these criteria defines the weighted combination at the pixel level of the multispectral images. A priori knowledge of road materials spectral signatures and definition of appropriate quality criteria are necessary to detect roads or runways by pixel fusion. They allow to define the appropriate configuration of spectral bands to merge so that the runway shows up clearly. This paper presents the obtained results from low-level fusion of five broad bands (approximately 100 nm wide). The main advantage of pixel fusion is the saving of processing time. On one hand, the multispectral data process is quick. On the other hand, the landing runway can be detected at long range, in a large field of view.
Derived from text
Command Guidance; Detection; Electro-Optics; Multisensor Applications; Multisensor Fusion; Navigation Instruments; Radiometers; Remote Sensing; Runways

19950026719 Lockheed-Fort Worth Co., Fort Worth, TX, United States
APPLICATION OF ADVANCED SAFETY TECHNIQUE TO RING LASER GYRO INERTIAL NAVIGATION SYSTEM INTEGRATION
Blaylock, James, Lockheed-Fort Worth Co., USA; Swihart, Donald, Wright Lab., USA; Stribula, Chuck, Aeronautical Systems Div., USA; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 10 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper documents the application of System-Wide Integrity Management (SWIM) to the integration of H-423 and LN-93 ring laser gyro (RLG) inertial navigation system (INS) units with the F-16 terrain following (TF) system. Safety modeling and mishap rate predictions are presented for F-16 TF with an RLG INS. This paper establishes that the H-423 and LN-93 RLG INS units are both safer for F-16 TF than the predecessor LN-39 gimballed, mechanical-gyro INS. The RLG INS design enhancements described are primarily built-in test (BIT) modifications that were developed as a result of the in-depth SWIM critical signal path analysis. These enhancements are low-cost design improvements to the RLG INS units because they were discovered prior to the manufacturer's final operational flight program (OFP) for the production units. This paper discusses dual-use applications of the RLG INS to other military and civilian functions, with design enhancements resulting from the SWIM process. Other military applications include not only specialized control modes such as TF, but also all other phases of the military flight operations regime, since the INS is always active to provide current aircraft state information. Civilian uses can also benefit from the SWIM process improvement to the RLG INS because accurate, reliable, safe navigation with critical timing along congested air routes, in weather, and in dense traffic terminal areas is of paramount importance for passenger safety.
Derived from text
Control Systems Design; F-16 Aircraft; Flight Safety; Inertial Navigation; Laser Gyroscopes; Military Technology; Ring Lasers; Systems Integration

19960003395 Advisory Group for Aerospace Research and Development, Guidance and Control Panel, Neuilly-Sur-Seine, France
AEROSPACE NAVIGATION SYSTEMS *LES SYSTEMES DE NAVIGATION AEROSPATIAUX*
Niemela, John, editor, Army Communications-Electronics Command, USA; Jun 1, 1995; 425p; In English; See also 19960003396 through 19960003413

Report No.(s): AGARD-AG-331; ISBN 92-836-1018-0; Copyright Waived; Avail: CASI; A18, Hardcopy; A04, Microfiche

The need for an up to date, comprehensive treatise on aerospace navigation systems has been recognized. It is anticipated that the target reader of this AGARDograph will be an individual who has the responsibility for the integration of navigation equipment aboard an aerospace vehicle. The AGARDograph is organized into six sections detailing the the motivation for establishing the requirements to assure that the development of an aerospace navigation system will meet its operational requirement; reviewing the navigation coordinate frames with a discussion of inertial, terrestrial, and geodetic coordinate systems; describing modern navigation sensor technologies; addressing the system analysis and synthesis methods; representing state-of-the-art navigation system implementations in different aircraft; and describing various test methods used to verify the performance of aerospace navigation systems used in NATO countries.

Air Navigation; Doppler Navigation; Inertial Navigation; Navigation Aids; Navigation Instruments; Radar Navigation; Remote Sensors; Satellite Navigation Systems; Space Navigation; Systems Analysis; Technology Assessment

19960003396 Defense Mapping Agency Systems Center, Fairfax, VA, United States

COORDINATE FRAMES

Kumar, Muneendra, Defense Mapping Agency Systems Center, USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 7-41; In English; See also 19960003395; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Accurate navigation requires an understanding of the three coordinate frames and systems which define positions in space. The first is the inertial frame in which the earth revolves around the sun annually. This annual motion is affected by the general precession and astronomic nutation and it takes place in the Earth Centered Inertial (ECI) frame or Conventional Inertial System (CIS). Second is the reference frame which is defined by the daily rotation of the earth around its polar axis. This Instantaneous Terrestrial System (ITS) frame requires knowledge of the sidereal time relationship with the CIS. Third frame is the geodetic or Earth Centered Earth fixed (ECEF) coordinate system defining the three-dimensional positions on the earth's surface or in its adjoining space. This frame is also known as Conventional Terrestrial System (CTS) and requires the knowledge of the earth's polar motion, the gravity field, and its size and shape. The ECI (or CIS) transformation to the ECEF (or CTS) frame makes use of the new theories of precession, astronomic nutation, change to a new J2000.0 Standard Time Epoch, the new definition of Universal Time as defined and adopted by the International Astronomical Union (IAU), and the latest ECEF frame, viz., Word Geodetic System (WGS) 1984. In the discussion that follows, all the coordinate frames or systems are right-handed and orthogonal, and positive rotation is clockwise when viewed from the origin towards the positive axis. Further, the three rotational matrices, R(sub x), R(sub y), and R represent the positive rotations about the orthogonal axes X, Y, and Z respectively.

Author

Coordinates; Earth Gravitation; Earth Orbits; Earth Rotation; Navigation Aids; Polar Wandering (Geology); Three Dimensional Motion

19960003397 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. for Flight Guidance., Brunswick, Germany

INERTIAL NAVIGATION

Stieler, B., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 45-131; In English; See also 19960003395; Copyright; Avail: CASI; A05, Hardcopy; A04, Microfiche

Inertial navigation system (INS) provides all information about the kinematics of a vehicle, namely attitude and heading, ground speed and position, and also angular rate and acceleration independent of any sources of reference from outside. No question about its role for military aviation, marine navigation and for missiles. A high inertial technology is nowadays a trademark for military independent of many countries. Inertial navigation is also widespread in use in civil aviation and in space flight. Any large civil aircraft is equipped with two or three inertial navigation reference systems. The advent of the 'Global Navigation Satellite System (GNSS)' will in principle not change this situation in the time to come, especially under the consideration that a solution for its undisturbed availability in times of strained political situations for the countries running the system is not yet in sight. This chapter is arranged in the following training of thoughts. The directional reference in an INS is explained with the mechanical gyro and stabilized platform as examples. It is symbolized by the weathercock in the functional diagram for a platform INS. The characteristics of the gyrostabilized platform as directional reference serve to visualize the characteristics of the 'analytic platform' in the navigational computer of modern strapdown systems. Again this is symbolized in a weathercock, the functional diagram for a strapdown system. Directional references and their error characteristics are discussed. Accelerometers as sensors for measuring the translational motion are fairly simple instruments in principle, but the formula for their output signal on the rotating earth is lengthy and it is the basis for programming the navigational computer of an INS. These aspects are treated in Section 3. The integration of the accelerometer signal to ground speed and position and the control or computation of the directional reference is subject of the navigational computer. The interlinking of all signals within and INS causes error characteristics more benign than we would expect from our school learning. This is subject of Section 4. Also the INS for worldwide navigation, common features and differences of all mechanizations are discussed. the goal is to derive the error model appropriate for integrating the INS with the other sensors and systems discussed in this book. The main part of this chapter contains only general outline which are essential from the system point of view. Special features as coordinate systems for inertial navigation supplementing the chapter 'Navigation Coordinate Systems', digital data processing of inertial signals especially in strapdown systems, and optical gyros are treated in the appendices wich are named correspondingly with C, D, and O.

Author

Accelerometers; Computer Systems Design; Control Systems Design; Directional Control; Gyroscopes; Inertial Navigation; Navigation Aids; Navigation Satellites; Stabilized Platforms; Surface Navigation

19960003398 GEC-Marconi Electronic Systems Corp., Wayne, NJ, United States

DOPPLER RADAR NAVIGATION

Buell, Heinz, GEC-Marconi Electronic Systems Corp., USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 132-151; In English; See also 19960003395; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The use of the Doppler principle to measure velocity has been underway since the early 1950's. The Doppler principle or effect has been applied to many systems in which velocity is an important variable. The discussion herein will concentrate on the use of a self-contained radar in an airborne vehicle to measure the velocity of that vehicle. Fixed-wing aircraft and helicopters have used Doppler radars successfully for many years, and drone aircraft and missiles are beginning to exploit the low cost and high reliability of Doppler radars.

Author

Doppler Effect; Doppler Radar; Flight Conditions; Frequency Shift; Instrument Errors; Radar Navigation; Technology Assessment

19960003399 Sandia National Labs., Albuquerque, NM, United States

TERRAIN REFERENCED NAVIGATION

Boozer, Drayton D., Sandia National Labs., USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 152-157; In English; See also 19960003395; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Terrain referenced navigation is a technique for improving the accuracy of a navigation system by correlating a sensed elevation profile of terrain beneath a vehicle with stored terrain elevation data. Position estimates are referenced to the terrain data and are insensitive to position bias errors in the terrain data. Because of this characteristic, terrain referenced navigation systems are especially useful in applications that require accurate navigation relative to targets, obstacles, structures, and other features whose locations are derived from the same source as the stored elevation data. Example applications include low-emission terrain following/terrain avoidance, target queuing for standoff weapon terminal sensors, indirect ranging and ground proximity warning. System navigation accuracy depends primarily on the ratio of terrain roughness to terrain data vertical accuracy and secondarily on navigation system accuracy, vehicle ground clearance, ground cover, vehicle maneuvers, and update frequency.

Terrain referenced navigation systems are often considered for use with terrain masking for covert, low-altitude ingress into hostile areas. Low probability of intercept radar altimeters may be used in these applications. A key issue is the availability and quality of terrain elevation data. This chapter provides avionics system developers an overview of terrain referenced navigation system capabilities and characteristics, and an outlook for future applications.
Author
Avionics; Nap-Of-The-Earth Navigation; Position Errors; Radar Targets; Radio Altimeters; Rangefinding; Surface Roughness; Terrain Following

19960003401 Directorate Research and Development Communications and Space, Ottawa Ontario, Canada
AN OVERVIEW OF OMEGA RADIO NAVIGATION SYSTEM
Liang, David F., Directorate Research and Development Communications and Space, Canada; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 177-186; In English; See also 19960003395; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Omega is a very low frequency (VLF) navigation system using frequencies allocated for radio navigation in the band between 10 KHz and 14 KHz. Such a low frequency band enables Omega navigation system to achieve the long operating ranges required for global coverage, at the same time provides a stable and predictable propagation environment. This also makes it the only radio navigation system applicable to completely submerged submarines. Omega is a hyperbolic position fixing system, the hyperbolae are loci of constant time difference between the arrival of signals from two transmitting stations. The time difference is measured as a difference in phase of the two received signals. Each hyperbola is known as a line of position (LOP). Signals must be received from at least three stations with one of them serving as a common station, to obtain a position fix from the two LOP's. The hyperbolic mode is attractive, since it removes the need to use a precise and expensive local oscillator. It is also possible to work with two stations using a circular mode, which requires a precision local oscillator. In such a case, the position fix is obtained from the intersection of circular rather than hyperbolic LOP's.
Author
Frequency Stability; Omega Navigation System; Radio Navigation; Technology Assessment; Underwater Communication; Very Low Frequencies

19960003402 Northrop Corp., Electronics Systems Div., Hawthorne, CA, United States
AGARDOGRAPH ON ADVANCED ASTROINERTIAL NAVIGATION SYSTEMS
Levine, Seymour, Northrop Corp., USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 187-199; In English; See also 19960003395; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper discusses modern Strapdown Astroinertial Navigation (SAIN) systems as autonomous navigators for manned aircraft, ships, missiles, and remotely piloted vehicles. These systems, which approach Global Positioning System (GPS) accuracy, do not depend upon man-made electromagnetic radiating devices that may be intentionally shut down, destroyed, or become unreliable in a hostile environment. The paper analyzes the gyroscopic accuracy, artificial stellar image stabilization, star density, sky visibility, and sky background irradiance effects on system performance. It concludes that a high-precision, reliable, low-cost stellar inertial system can be achieved by eliminating gimbals and combining a strapdown Inertial Navigation System (INS) with an Optical Wide-Angle-Lens Startracker (OWLS).
Author
Accelerometers; Autonomy; Gyroscopes; Inertial Navigation; Navigation Instruments; Navigators; Systems Analysis; Technology Assessment

19960003403 Smiths Industries Aerospace and Defense Systems, Inc., Avionics Systems Engineering., Grand Rapids, MI, United States
MAGNETIC HEADING REFERENCES
Moore, Donald L., Smiths Industries Aerospace and Defense Systems, Inc., USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 200-205; In English; See also 19960003395; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper addresses the most common system for providing aircraft heading reference: the magnetic heading reference system. It begins briefly explaining the importance of a magnetic heading reference. It then addresses the fundamental characteristics of the earth's magnetic field and explains the concept of 'magnetic variation'. It discusses two of the more common styles of magnetic heading sensors along with their inherent errors. After explaining how these different compasses operate, the paper explains the different types of heading errors that occur. Section 4 addresses the in-flight errors, while Section 5 addresses the magnetic disturbances caused by the aircraft itself. Section 6 discusses calibration techniques that provide for the correction against these magnetic disturbance induced errors. Finally, this paper concludes with a brief discussion of future trends.
Author
Air Navigation; Compasses; Earth (Planet); Geomagnetism; Magnetic Variations; Navigation Aids

19960003404 Directorate Research and Development Communications and Space, Ottawa Ontario, Canada
AN OVERVIEW OF A GENERIC MULTI-SENSOR INTEGRATED NAVIGATION SYSTEM DESIGN
Liang, David F., Directorate Research and Development Communications and Space, Canada; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 210-230; In English; See also 19960003395; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Modern avionics systems are becoming increasingly sophisticated as the demands for better mission performance and higher reliability continue to escalate. Many of the missions must be carried out at ultra-low altitude under all weather and visibility conditions. The increased range, speed and accuracy of modern weapon systems, impose stringent accuracy and reliability requirements upon the aircraft navigation system. to enhance mission success in a hostile environment, the pilot amongst other things needs to operate weapon systems, target acquisition and designation systems, radar detection, night vision systems and perhaps engage in air-to-air combat. This paper describes the application of Kalman filtering technology to the design and development of a multi-sensor Generic Integrated Navigation System (GINS).
Author
Air Navigation; Avionics; Kalman Filters; Multisensor Applications; Systems Engineering; Systems Integration; Technology Assessment

19960003405 Wright Lab., Avionics Directorate., Wright-Patterson AFB, OH, United States
DEEP INTEGRATION OF GPS, INS, SAR, AND OTHER SENSOR INFORMATION
Lewantowicz, Zdzislaw H., Wright Lab., USA; Paschall, Randall N., Wright Lab., USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 231-264; In English; See also 19960003395; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This discussion is presented in the context of avionics sensor integration methodology. However the concepts developed and illustrations presented are in no way limited in application to military avionics systems. There is a growing number of civil applications, where information from multiple sensors is combined to improve performance, provide redundancy management, increase robustness, or achieve graceful degradation when sensor failures (or outages) occur. We are rapidly moving beyond the classical examples of sensor information integration such as in aircraft navigation, or in control of chemical processes, nuclear plants, and jet engines. For example, the automotive industry is using several sensors for engine emissions and fuel control, vehicle active suspension, and yes, vehicle electronics (vetronics). Communication systems, position, velocity, and attitude (rotation) sensors, and other information are rapidly appearing in the consumer automobiles. These sensors provide, at affordable cost, functional capabilities, which until recently were reserved for the more expensive commercial air and ground systems. Other applications of sensor integration are either being implemented, prototyped, or considered in toys, electronics, consumer products, such as the household washers and dryers, communications, and home environment monitoring and control systems. Although the sensor integration possibilities are expanding into these other domains, this discussion focuses on deep integration of Global Posi-

tioning System (GPS), inertial navigation systems (INS), synthetic aperture radar (SAR), and other sensors which are a subset of modern aerospace systems.
Author
Air Navigation; Global Positioning System; Inertial Navigation; Remote Sensors; Synthetic Aperture Radar; Systems Integration; Technology Assessment; Technology Utilization

19960003407 Draper (Charles Stark) Lab., Inc., Cambridge, MA, United States
GPS/INERTIAL INTEGRATION OVERVIEW
Greenspan, Richard L., Draper (Charles Stark) Lab., Inc., USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 281-294; In English; See also 19960003395; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

GPS/Inertial integration is the process whereby a superior system navigation solution is produced by properly combining outputs from a GPS user equipment (UE) and from an inertial navigation system (INS). This process is receiving much attention because it is perceived to be a cost-effective means to satisfy navigation requirements that could not be met by either GPS or by an INS acting by itself. Some expectations levied on integrated systems are realistic; others, including hopes for mass-market commercial applications, will be delayed pending the development of suitable low-cost inertial technology. The technical basis for considering GPS/INS integration is the complementary nature of the navigation errors for each system operating stand-alone. The GPS solution is relatively noisy; the noise-driven variance of GPS positioning errors is on the order of a meter per axis, per position determination. However, GPS errors are bounded, whereas inertial navigation errors are dominated by a low-frequency component that grows in proportion to the mission duration. (The high-frequency content of inertial errors is very small, amounting to a few centimeters (rms) over tens of seconds.) One expects that an integrated navigation solution would perform like an inertial navigator whose errors were bounded by the GPS solution. This performance is actually achieved using one of the least aggressive approaches to integration; further benefits achieved using more aggressive integration options are discussed in the following sections.
Author
Global Positioning System; Inertial Navigation; Navigators; Systems Integration; Technology Assessment; Technology Utilization

19960003409 Litton Guidance and Control Systems, Woodland Hills, CA, United States
VERTICAL CHANNEL DESIGN CONSIDERATIONS
Ausman, J. Stanley, Litton Guidance and Control Systems, USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 312-327; In English; See also 19960003395; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The vertical channel of an inertial system is unstable. This instability is caused by the gravity compensation fed back to the vertical accelerometer output. The gravity compensation, computed as a function of altitude after doubly integrating the output of that accelerometer, creates an unstable, positive feedback loop. The time constant of this instability is about 560 seconds near the earth's surface. For ballistic missiles and rockets this does not pose a problem because the guidance is completed before the instability becomes serious. For aircraft systems, however, one must augment the inertial measurements, typically with barometric altimeter information, in order to stabilize the vertical inertial channel. Earliest mechanizations of the baro-inertial loop employed second-order feedback with constant gains. The next step was to add integral feedback in order to bias the vertical accelerometer, thus creating a third-order system. Widnall and Sinha investigated the third-order loop to find the optimum set of fixed gains. Not surprisingly, they found that the optimum set of gains depended on the values assumed for the noise characteristics of the accelerometer and the barometric altimeter. Because the noise magnitudes will vary as a function of the aircraft's flight regime, the baro-inertial feedback gains should not be constant, but should also vary. Litton first mechanized a third-order variable gain baro-inertial loop in CLASS, in all-weather close air support system, successfully demonstrated in 1972. They gradually improved upon that basic design over the years as successive systems, principally ARIS, uncovered more and more barometric altitude error characteristics which had to be accommodated. The culmination of this evolutionary development is the baro-inertial loop currently mechanized in the LN-93 and LN-94 systems for the USAF Standard RLG INU. Following a discussion of barometric and inertial errors, we will take a detailed look at the LN-93/94 conventional vertical channel mechanization, the reasons behind the loop design, and some simulation results illustrating the loop performance when subjected to certain flight maneuvers and barometric errors.
Author
Accelerometers; Altimeters; Altitude Control; Channels (Data Transmission); Design Analysis; Gravitational Effects; Inertial Navigation; Kalman Filters; Positive Feedback

19960003411 Army Communications-Electronics Command, Research and Development Center., Fort Monmouth, NJ, United States
REPRESENTATIVE VEHICLE IMPLEMENTATION: ROTARY WING AIRCRAFT
Niemela, John, Army Communications-Electronics Command, USA; Liang, David F., Directorate Research and Development Communications and Space, Canada; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 381-389; In English; See also 19960003395; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Rotary wing aircraft have seen an ever expanding role in support of land and sea military operations including: search and rescue, scout, attack, troop transport, anti-submarine warfare, anti-surface ship targeting, cargo and electronic warfare. They are ideally suited for operation in confined and unprepared areas where no other form of aerial transport is suitable. For a helicopter to survive on the modern battlefield, flight profiles are mandated that impose unique requirements on the navigation system. These include contour and nap-of-the-earth flight as well as hover in defilade in close proximity to obstructions. Critical mission segments are conducted in nap-of-the-earth flight during which the pilot conceals the helicopter with terrain, foilage and buildings. These missions must be accomplished in all weather and visibility conditions. In the course of these missions, the rotary wing aircraft crew must maintain accurate self-location to maintain geographic orientation and situational awareness relative to friendly and hostile forces. A typical tactical mission profile overlaid on a contour map is shown, illustrating the non-linear flight path which takes advantage of terrain masking. For the anti-submarine warfare missions the helicopter navigation system must maintain stable and accurate tactical plots over long periods of time. In the anti-surface ship targeting role, a high degree of absolute and relative navigational accuracy are vital to rapid and successful action. There are further complicating factors as well. Operations must often take place under radio silence and shore-based or satellite navigation aids may be destroyed or jammed during wartime. The small crew of the helicopter must not be burdened with monitoring the functioning of, or updating, the navigation system.
Author
Air Navigation; Design Analysis; Flight Paths; Military Operations; Nap-Of-The-Earth Navigation; Navigation Aids; Rotary Wing Aircraft; Technology Assessment; Terrain Following

19960003413 Test Squadron (0046th), Holloman AFB, NM, United States
TEST METHODOLOGY
Hunt, Coy L., Test Squadron (0046th), USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 407-421; In English; See also 19960003395; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This section of the document describes the various methods employed to evaluate the performance of aerospace navigation systems. Included are discussions regarding test equipment, test data, reference systems, environmental conditions, laboratory tests, flight test profiles and procedures, and statistical methods used to measure system performance. The test methods detailed in this document are somewhat specific and may need to be adapted to particular systems and their specifications.
Author
Air Navigation; Computer Systems Performance; Data Systems; Performance Prediction; Prediction Analysis Techniques; Space Navigation; Statistical Analysis

19960012295 NASA Ames Research Center, Moffett Field, CA, United States
DESIGN PRINCIPLES AND ALGORITHMS FOR AUTOMATED AIR TRAFFIC MANAGEMENT
Erzberger, Heinz, NASA Ames Research Center, USA; AGARD,

Knowledge-Based Functions in Aerospace Systems; Nov 1, 1995, 31 p; In English; See also 19960012290; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper presents design principles and algorithm for building a real time scheduler. The primary objective of the scheduler is to assign arrival aircraft to a favorable landing runway and schedule them to land at times that minimize delays. A further objective of the scheduler is to allocate delays between high altitude airspace far from the airport and low altitude airspace near the airport. A method of delay allocation is described that minimizes the average operating cost in the presence of errors in controlling aircraft to a specified landing time.
Author

Air Traffic Control; Aircraft Approach Spacing; Algorithms; Automatic Control; Design Analysis; Flight Paths; Flight Plans; Real Time Operation; Scheduling

19960012296 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Flight Guidance., Brunswick, Germany
STRUCTURES, ARCHITECTURES AND DESIGN PRINCIPLES FOR DYNAMIC PLANNING FUNCTIONS IN ATM
Voelckers, Uwe, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Boehme, D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Knowledge-Based Functions in Aerospace Systems; Nov 1, 1995, 18 p; In English; See also 19960012290; Avail: CASI; A03, Hardcopy; A02, Microfiche

Air Traffic Management (ATM) is a very complex and challenging domain. To cope with future traffic demand, while still maintaining or even increasing safety and efficiency of air traffic operations, intelligent machine functions have to be developed to assist the human operators in their mental control tasks. The specific requirements of the ATM domain necessitate sophisticated and well-designed assistance tools. Their most significant characteristics, design principles and structures are discussed and examplified in a real-world application.
Author

Air Traffic Control; Flight Safety; Human-Computer Interface; Planning; Scheduling; Systems Analysis

19960016906 Elektroniksystem- und Logistik G.m.B.H., Munich, Germany
SIMULATION MODELS FOR IFF SYSTEM PERFORMANCE ANALYSIS
Walberer, A., Elektroniksystem- und Logistik G.m.B.H., Germany; Oct. 1995; 10p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Indentification Friend or Foe (IFF) is an important means of air traffic surveillance for military air operation. Due to this fact, several studies of IFF equipment were conducted in the past. to assist the analysis of IFF system performance, two simulation models have been developed at 'Elektroniksystem- und Logistik GmbH' in Munich, Germany. The description of these models is the main subject of this paper. The first model is based on a probabilistic methodology. It operates on a scenario reflecting te environment to be considered. The model determines the interrogation rates at each transponder deployed in the environment. Applying the probability theory, the behavior of the transponders is predicted and their reply rates are obtained. The reply rates are the input for the calculation of the signal loads at the interrogators and the establishment of their behavior. The second model is designed as a discrete-event simulation model. At each point in time an interrogation is generated, the arrival times and the power levels of the interrogation at the transponders are determined. The processing of the interrogation by the transponders is modelled by taking into account the various interference mechanisms. If a reply is challenged by an interrogation, the arrival times and the signal power levels at the interrogators are calculated. Interferences with the reply are checked in order to establish the proper evaluation of the signal by the interrogator.
Derived from text

IFF Systems (Identification); Computer Systems Performance; Military Operations; Reliability Analysis; Systems Analysis; Mathematical Models; Warning Systems; Transponders; Surveillance Radar

19960017677 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
TWENTY-FIVE YEARS OF CONTRIBUTIONS TO AIR TRAFFIC HANDLING (RESEARCH, DEVELOPMENT, OPERATIONS AND HISTORY): A BIBLIOGRAPHY *VINGT-CINQ ANNEES DE CONTRIBUTIONS AU CONTROLE DU TRAFIC AERIEN (RECHERCHES, DEVELOPPEMENT, OPERATIONS ET HISTORIQUE): UNE BIBLIOGRAPHIE*
Benoit, Andre, Editor, European Organization for the Safety of Air Navigation, Belgium; Feb. 1996; 168p; In English
Report No.(s): AGARD-R-811; AD-A305389; ISBN 92-836-1029-6; Copyright Waived; Avail: CASI; A08, Hardcopy; A02, Microfiche

Over 25 years, the Guidance and Control Panel of the Advisory Group for Aerospace Research and Development to the North Atlantic Treaty Organization has devoted part of its activities to the fascinating field known historically as Air Traffic Control, covering also Air Traffic Management, and more generally Air Traffic Handling. This Report provides a list of the summaries of the papers which were presented at the symposia and included in the AGARDographs devoted to this wide and most challenging subject, covering essentially, Air Traffic Control Systems (1972); A Survey of Modern Air Traffic Control, Vols. 1 and 2 (1975); Plans and Developments for Air Traffic Systems (1975); Air Traffic Management (1979); Air Traffic Control in Face of Users' Demand and Economy Constraints (1982); Efficient Conduct of Individual Flights and Air Traffic (1986); Aircraft Trajectories, Vols. 1, 2 and 3 (1990); Machine Intelligence in Air Traffic Management (1993); and On-Line Handling of Air Traffic (1994). The Report is completed by two indexes, an extended subject Index, and an Authors and Contributors Index.
Author

Bibliographies; Air Traffic Control; Air Traffic; Management Methods; Control Systems Design

19960022249 Science Applications International Corp., Arlington, VA United States
MEASUREMENTS OF GPS AND LORAN PERFORMANCE IN AN URBAN ENVIRONMENT
Miller, Lance C., Science Applications International Corp., USA; Vaurio, David, Science Applications International Corp., USA; Giambalvo, Albert, Science Applications International Corp., USA; Karp, Sherman, Science Applications International Corp., USA; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 10p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

During the summer of 1994, the Advanced Research Projects Agency funded an experiment to collect extensive radionavigation data in the New York City area. The participants are listed under the Acknowledgments. The data includes the accuracy and availability of the Global Positioning System (GPS) and LORAN-C, the increased availability of both GPS and LORAN by adding a precise oscillator input to the receivers, and a comparison of electric field (E-field) and magnetic field (H-field) LORAN signal availabilities. Analysis of the data shows: (I) in the deep urban canyons of Wall Street, the availability of LORAN (either E or H field) is higher than that of GPS; (2) in almost all scenarios, the LORAN magnetic field signal is easily detectable and has repeatable phase characteristics. In contrast, the LORAN electric field signal strength is frequently attenuated and undetectable, especially in the Wall Street area and under the elevated train tracks in the Bronx; (3) when corrected for propagation anomalies, the inherent repeatable accuracy of LORAN is 7-10 meters rms with under 100 meters rms potentially obtainable in an operational differential mode; and (4) the availability of radionavigation fixes can be enhanced in these urban areas by the integration of LORAN and GPS navigation information and by the use of a precise oscillator which allows a geographic fix to be made by receiving as few u two time of arrival broadcasts, e.g. one GPS satellite and one LORAN station.
Author

Global Positioning System; LORAN C; LORAN; Navigation Satellites; Electric Field Strength; Radio Navigation; Magnetic Fields

19960022250 Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Euskirchen, Germany
SUSCEPTIBILITY MEASUREMENTS ON GPS RECEIVERS
Braun, Ch., Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Germany; Guidi, P., Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Germany; Schmidt, H. U.,

Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Germany; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 10p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper describes our low power microwave coupling measurements on hand-held GPS (Global Positioning System) receivers in the frequency range between 0.3...2 GHz. The plane wave excitation experiments have been carried out mainly in our field coupling facility, which consists of an asymmetric triplate transmission line with maximum CW field levels of up to 120 V/m at the test position. As test objects we examined four Standard Positioning Service (SPS) C/A-code GPS receivers of different manufacturers. The test objects were positioned in the simulator in three orthogonal orientations with respect to the external field. to maintain a high-integrity navigation, the GPS receiver must maintain lock on the satellite signal and read the data. A three dimensional position (latitude, longitude and altitude) at least requires four satellites to be in view. Failure is defined when this 3 D fix is lost. It turned out that the GPS were most susceptible to CW fields with its internal antenna. They were less susceptible if the receiver and the GPS antenna were placed separately and linked together via a cable. Worst case effects caused GPS switch off, but no damage occurred at field strengths below 100 V/m at out-of-band frequencies. Pulse testing (width = 20 microns) the GPS always required much higher fields to cause upsets depending strongly on frequency and test object. In some cases pulsed fields of more than 2 kV/m were necessary.

Author

Global Positioning System; Receivers; Field Strength; Frequencies; Plane Waves

19960042824 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France

SYSTEM IMPLICATIONS AND INNOVATIVE APPLICATIONS OF SATELLITE NAVIGATION ***LES APPLICATIONS NOUVELLES OFFERTES PAR LA NAVIGATION PAR SATELLITE ET LEURS INCIDENCES AU NIVEAU SYSTEMES***

Jun. 1996; 168p; In English, 1-2 Jul. 1996, Paris, Rome, Madrid, Saint Petersburg, France, Italy, Spain, Russia; See also 19960042825 through 19960042834

Report No.(s): AGARD-LS-207; ISBN 92-836-1038-5; Copyright Waived; Avail: CASI; A08, Hardcopy; A02, Microfiche

The Global Positioning Satellite System (GPS) is now operational and GLONASS will soon be declared operational. Meanwhile, INMARSAT has announced its intent to expand its services to include navigation signals broadcast from geostationary satellites, and several industrial organizations plan to provide commercial, satellite-based, navigation services. With prospects for reliable worldwide service becoming a reality, the technical and financial barriers to innovative applications are being overcome. This Lecture Series will provide an appreciation of the technical, operational and performance features of satellite-based navigation including the signal-in-space and the user equipment for GPS, GLONASS, and integrated GPS/GLONASS implementations; assessment of the quality of service that has been achieved and an introduction to projected service enhancements. The introductory lecture will provide an overview of Satellite based navigation and some of the imaginative uses to which it has already been put. The application of satellite signals to precision approach and landing for civil aviation and for the determination of vehicle attitude (orientation) will be featured in the following lectures. Other topics include quality monitoring of user's navigation solutions, the integration of satellite navigation with inertial measurements and high-precision relative and differential positioning. This Lecture Series, sponsored by the Mission Systems Panel of AGARD, has been implemented by the Consultant and Exchange Program.

Author

Lectures; Global Positioning System; GLONASS; Inmarsat Satellites; Geosynchronous Orbits; Satellite Constellations; Civil Aviation; Navigation Satellites; Accuracy; Position (Location)

19960042825 Draper (Charles Stark) Lab., Inc., Cambridge, MA United States

GLOBAL NAVIGATION SATELLITE SYSTEMS

Greenspan, Richard L., Draper (Charles Stark) Lab., Inc., USA; System Implications and Innovative Applications of Satellite Navigation; Jun. 1996; 10p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The Global Navigation Satellite System (GNSS) is the visionary goal for a world-wide utility that will ultimately provide reliable and dependable navigation and timing services to civil and national users. The enabling technology is firmly rooted in operational satellite navigation systems that have been developed for military use, including the Global Positioning Satellite System (GPS) and the Global Navigational Satellite System (GLONASS) developed in the USA and Russia respectively. However, the rapid acceptance into operational use by the civil community of even the degraded performance levels that have already been made available has exposed the need for additional features of the existing signals to deliver improved services. Although these additional features will be provided initially as augmentations to the existing systems, the GNSS, in whatever form it eventually takes, remains the end point toward which governments, international service providers, industry and user groups are planning. This introductory lecture provides an overview of the means by which individual design features of satellite navigation systems are seen to satisfy the mission requirements for specific user groups, and it sets the context for the other presentations in this lecture series. This presentation is organized from the viewpoint of the users of the satellite navigation services; it also includes a review of some applications of theses services that were not even remotely anticipated by their original designers. Most of this discussion is based on the Global Positioning Satellite System.

Author

Global Positioning System; GLONASS; Satellite Constellations; Navigation Satellites; International Cooperation; Operating Costs; Position (Location); Position Sensing; Accuracy

19960042826 Ministry of Defence, State Scientific and Research Inst. for Navigation and Hydrography., Saint Petersburg, Russia

INTRODUCTION TO GLOBAL NAVIGATION SATELLITE SYSTEM

Bazarov, Y., Ministry of Defence, Russia; Jun. 1996; 22p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The Russian Global Navigation Satellite System (GLONASS) is a space-based positioning, velocity and time system. In this lecture the evolution of GLONASS towards operational status is presented. The operational constellation, the constellation maintenance plan and relenishment policy, coverage and dilution of precision factors are described along with the Russian national policy for user access to the service. The lecture addresses the characteristics of GLONASS broadcast signals in space including modulation techniques, code structure, message content and formats, navigational accuracy achieved by GLONASS users, differential technique, user equipment performance, future GLONASS upgrades and applications of GLONASS in the Commonwealth of Independent States are described.

Author

GLONASS; Navigation Satellites; Satellite Constellations; Accuracy; Frequency Modulation; Position (Location); Time Signals; Position Indicators

19960042827 Three-S Navigation, Laguna Hills, CA United States

INTEGRATED GPS/GLONASS USER EQUIPMENT

Beser, Jacques, Three-S Navigation, USA; Jun. 1996; 28p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Integrated Global Positioning System/Global Satellite Navigation Systems (GPS/GLONASS) receivers offer better availability, performance, and integrity than GPS only receivers. In this lecture, the GPS and GLONASS systems are compared and the advantages and difficulties associated with their combined use are discussed. The 3S Navigation R-100 series of receivers is used as a model to discuss the various receiver components and functions, including the antenna, RF/IF unit, tracking module, measurement generation and navigation

solution generation. The R-100 architecture is described as well as that of the GNSS-200 which is more compact and the latest GPS/GLONASS receiver produced by 3S Navigation. Air, sea and ground results are presented. These include results for both the R-100 series as well as the GNSS-200. Stand-alone as well as differential performance are discussed.
Author
Global Positioning System; GLONASS; Satellite Constellations; Accuracy; Position (Location); Position Indicators; Antenna Radiation Patterns

19960042828 Calgary Univ., Dept. of Geomatics Engineering., Alberta Canada
NAVIGATION ACCURACY FOR ABSOLUTE POSITIONING
Lachapelle, Gerard, Calgary Univ., Canada; Jun. 1996; 10p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The real-time absolute (i.e., single point, stand-alone) accuracy achievable with the Global Positioning System (GPS) is a function of the User Equivalent Range Error (UERE) and the Dilution of Precision (DOP). The later parameter is a function of satellite geometry. The various error components affecting the magnitude of the UERE are quantified. They include satellite, atmospheric, and receiver dependent errors. The DOP's expected under ideal operational conditions are a function of space and time. The absolute accuracies currently specified for the Standard Positioning Service (SPS) and the Precise Positioning Service (PPS) are described. Various experiments conducted in recent years show that he actual PPS accuracy performance usually exceeds the specified level. Potential PPS accuracy enhancements which comprise satellite clock and ephemeris error reduction, tropospheric error reduction and receiver noise and multipath reduction are described. Recent tests by the 50th Space Wing of the US Air Force to reduce satellite clock and ephemeris errors show an improvement of nearly 50% in absolute positioning accuracy using current Y-code receiver technology. As a military application example, a comparison of the NATO STANAG 2373 artillery survey requirements with PPS accuracies shows that the artillery positioning requirement can be met under ideal satellite geometry with the currently specified PPS accuracy. Future PPS accuracy enhancements show that the artillery positioning requirements could be met under severely degraded satellite geometry, which is a more realistic scenario, given the concealment requirements for artillery. Selected recommendations of an independent study mandated by the US Congress and conducted by the National Academy of Public Administration and the National Research Council pertaining to both PPS and SPS enhancements are presented. Finally, the impact of the worldwide civilian GPS tracking network deployed by the International GPS Service for Geodynamics on post-mission absolute accuracy is discussed. The use of post-mission precise orbits and 30-second satellite clock corrections are resulting in absolute kinematic accuracies at the 1-3 m accuracy level using civilian receivers. The potential for this post-mission information to become available in real-time is mentioned.
Author
Global Positioning System; Multipath Transmission; Real Time Operation; Tracking Networks; Timing Devices; Accuracy; Position (Location); Position Indicators; Signal Encoding; Error Analysis; Positioning

19960042829 Draper (Charles Stark) Lab., Inc., Cambridge, MA United States
RELATIVE AND DIFFERENTIAL GPS
Phillips, Richard E., Draper (Charles Stark) Lab., Inc., USA; Schmidt, George T., Draper (Charles Stark) Lab., Inc., USA; Jun. 1996; 22p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Many aerospace vehicles will have an avionics suite that includes an integrated inertial navigation system/Global Positioning System (INS/GPS) set. This means of navigation motivates examination of whether high accuracy (approx. equals 10 ft Circle of Equal Probability (CEP)) may be obtainable using only this set of weapon avionics operating in a relative or differential GPS mode, rather than in an absolute GPS mode where CEP's of 30 to 40 feet would be expected. This paper will explain how 10 ft accuracy may be achieved and it will present several different concepts that exploit such a capability. Fundamentally, two problems must be solved to achieve an accuracy of 10 ft: (1) destination or 'target' location must be determined to better than 10 ft, and (2) the GPS/INS 'user vehicle' must be guided accurately to better than 10 ft. This paper will explain how the use of relative GPS can solve the guidance problem and how the use of relative targeting in a GPS based coordinate system can solve the target location problem. The use of differential GPS will also be discussed. The paper begins with a discussion of relative GPS and reports the results of actual experiments to determine accuracy degradation of relative GPS guidance systems as a function of baseline length and targeting latency. Various baseline lengths and latencies are considered showing that relative (or differential) GPS guidance may achieve high accuracy over baselines and latencies useful for various applications. Appendix A shows that to first order, relative and differential GPS systems give the same accuracy. Next, the target location part of the problem is addressed. There must be an accurate sensor that locates the target relative to the GPS reference receiver. The sensor may be either on the vehicle carrying the receiver or at a remote location. The reference receiver could either be on the surveillance aircraft or on the ground. If on the ground, both it and the target could have been located prior to the mission. Real-time target location concepts that will be explained include the use of aircraft equipped with an INS/GPS/Synthetic Aperture Radar (SAR) avionics suite to perform a real-time relative targeting function. The importance of reasonable aircraft maneuvers to enhance observability and speed up the three dimensional (3-D) target determination solution will also be addressed. Simulation results for several realistic scenarios will be presented. An example of an INS/GPS equipped guided parafoil for supply delivery will be discussed as one of the relative (or differential) GPS applications. Next, several concepts will be discussed that make use of highly accurate pre-mission relative target positioning, i.e., the ability to specify the 3-D location of two points, or localized areas, on the Earth relative to each other in a suitable reference frame such as WGS-84. It is of interest to speculate how such a capability could be exploited. Scenarios involving several existing or planned systems will be described. A detailed design example of an INS/GPS guidance system for a munition fired from a gun will then be presented. A final section will then discuss some of the practical issues in using relative (or differential) GPS.
Author
Avionics; Global Positioning System; Inertial Navigation; Position (Location); Positioning; Real Time Operation; Synthetic Aperture Radar; Accuracy; Tracking (Position)

19960042830 Ohio Univ., Avionics Engineering Center., Athens, OH United States
REQUIREMENTS ON GNSS FOR CIVIL NAVIGATION
vanGraas, F., Ohio Univ., USA; Jun. 1996; 8p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The civil aviation community has had decades of experience in regulating the quality of land-based navigation aids and developing the procedures for their use that guarantee safe operation. The drafting of these principles and procedures into standards for satellite-based navigation aids has now been underway for more than a decade. This lecture will trace the evolution towards internationally-accepted definitions of 'required navigation performance' including accuracy, integrity, continuity, and availability considerations. Inasmuch as this is an on-going activity, the lecture will include a road map for the completion of actions that are underway.
Author
Civil Aviation; Navigation Aids; Satellite Constellations; Satellite Navigation Systems; Standards; Air Navigation; Air Traffic Control; Aircraft Guidance; Accuracy; Approach Control; International Cooperation

19960042831 Ohio Univ., Avionics Engineering Center., Athens, OH United States
SIGNALS INTEGRITY
vanGraas, F., Ohio Univ., USA; Jun. 1996; 12p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Providers of a global navigation satellite system (GNSS) service will be required to demonstrate that users of their service will be informed within a limited time (now set at ten seconds for terminal area navigation and non-precision approach) of any satellite that fails to operate within its range of acceptable signal quality The lecture will describe approaches to provide this 'integrity' feature including

receiver autonomous integrity monitoring (RAIM) as well as systematic approaches that involve augmentations of the navigation satellite constellation. Prominent among these is the wide area augmentation system for the Global Positioning System (GPS).
Author
Area Navigation; Global Positioning System; Satellite Constellations; Navigation Satellites; Integrity; Warning Systems; Air Traffic Control; Position Errors; Position (Location); Fault Detection

19960042832 Ohio Univ., Avionics Engineering Center., Athens, OH United States
GNSS AUGMENTATION FOR HIGH PRECISION NAVIGATION SERVICES
vanGraas, F., Ohio Univ., USA; Jun. 1996; 14p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The absolute positioning accuracy of current or planned global navigation satellite system (GNSS) services is not good enough to support Category 3 precision approach and landing requirements, nor is it good enough to support high precision survey applications. The leading solution to this problem is to augment the basic service. the survey community has developed relative positioning techniques based on continuously tracked carrier phase measurements. A static or dynamic user compares accumulated carrier phase measurements to a specific set of satellites with simultaneous measurements taken by a reference receiver at a well surveyed location. The civil aviation community is also exploring 'local area' differential (GPS) concepts in which one or more reference beacons augment the satellite beacons in the vicinity of an airport. The lecture will identify the leading candidates for these augmentations and will characterize predicted performance improvements, and will present results of recent flight tests.
Author
Accuracy; Beacons; Civil Aviation; Global Positioning System; Navigation Satellites; Position (Location); Position Errors; Position Sensing; Geodetic Surveys; Doppler Effect

19960042833 Draper (Charles Stark) Lab., Inc., Cambridge, MA United States
GPS/INS INTEGRATION
Phillips, Richard E., Draper (Charles Stark) Lab., Inc., USA; Schmidt, George T., Draper (Charles Stark) Lab., Inc., USA; Jun. 1996; 18p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

An inertial navigation solution exhibits relatively low noise from second to second but tends to drift over time. Typical aircraft inertial navigation errors grow at rates between one and ten nautical miles per hour (1.8 to 18 km/hr) of operation. In contrast global navigation satellite system (GNSS) errors are relatively noisy from second to second but exhibit no long term drift. Using both os these sensors is superior to using either alone. Integrating the information from each sensor results in a navigation system which operates like a drift free INS. There are further benefits to be gained depending on the level at which the information is combined. This presentation will focus on integration architectures including 'loosely coupled ' and 'tightly coupled' configurations. The advantages and disadvantages of each level of integration is listed. Examples of current and future systems will be cited. A performance comparison of 'loosely coupled' and 'tightly coupled' systems will be made. Navigation applications for which integration is essential will be given.
Author
Inertial Navigation; Global Positioning System; Position Errors; Velocity Measurement; Signal to Noise Ratios; Doppler Effect; Systems Integration; Drift (Instrumentation); Multisensor Fusion

19960042834 Calgary Univ., Dept. of Geomatics Engineering., Alberta Canada
ATTITUDE DETERMINATION
Lachapelle, Gerard, Calgary Univ., Canada; Jun. 1996; 16p; In English; See also 19960042824; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The fundamental concept of precise attitude determination with multi-antenna Global Positioning System (GPS) receiver technology is described. The characteristics of the observable used for this purpose, namely the carrier phase, are summarized with emphasis on phase noise and multipath which constitute the major error sources. Given a multi-antenna configuration mounted on a rigid platform, the procedure to successively fix the double difference integer carrier phase ambiguity between the nearby antennas, obtain sub cm-level tri-dimensional relative position vectors and transform them into the attitude components, namely roll, pitch, and heading, is described. The two-antenna case, which allows pitch and heading determination, is presented as a special case. Integer ambiguity resolution between the antennas turns out to be relatively easy to achieve with single frequency (L sub 1) data because the differential orbital and atmospheric errors are negligible and the fixed distances can be used as constraints to speed up the ambiguity resolution process. The use of various antenna configurations to recover the carrier phase ambiguities instantaneously is mentioned. The attitude accuracy is a function of several parameters, namely satellite configuration, inter-antenna separation, phase noise and prevailing multipath conditions. Two multi-antenna hardware approaches to the problem of attitude determination are described using various case studies, namely a dedicated multi-antenna receiver approach which allows real-time operation and a multi-GPS sensor approach which can be used in real-time only if the data from each sensor is transferred to a central processor as the measurements are made. If post-mission results only are required, no data links involving the sensors are required since the phase measurements can be precisely synchronized using the time obtained from the code measurements. The effect of signal masking on attitude determination, which is relatively severe due to the carrier phase ambiguity problem is discussed. The effect of relative platform motion, e.g., wing flexure in the case of an aircraft, on attitude determination performance is discussed. The case studies used deal with shipborne, aircraft, and land cases. The results with several multi-antenna systems deployed in various configurations are presented.
Author
Attitude (Inclination); Global Positioning System; Multipath Transmission; Real Time Operation; Receivers; Position Errors; Antenna Design; Ambiguity; Lateral Oscillation; Radio Antennas

19960053046 Draper (Charles Stark) Lab., Inc., Cambridge, MA United States
PRECISION STRIKE CONCEPTS EXPLOITING RELATIVE GPS TECHNIQUES
Schmidt, George, Draper (Charles Stark) Lab., Inc., USA; Setterlund, Roy, Draper (Charles Stark) Lab., Inc., USA; Jun. 1996; 12p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Many weapons and weapon carriers will have an avionics suite that includes an integrated inertial navigation system/global positioning system (INS/GPS) set. This means of navigation motivates examination of whether very high accuracy (about 10 ft) circular error probable (CEP) may be obtainable using only this set of weapon avionics operating in a relative GPS mode, rather than in an absolute GPS mode where CEPs of 30 to 40 ft would be expected. This paper will explain how 10 ft accuracy may be achieved and it presents several different weapon system concepts that exploit such a capability to rapidly attack targets.
Author
Avionics; Global Positioning System; Inertial Navigation; Precision Guided Projectiles; Target Acquisition; Target Recognition; Ordnance; Position (Location); Fire Control

19960053047 Department of the Air Force, Eglin AFB, FL United States
CARRIER PHASE GPS TIME, SPACE, POSITION INFORMATION DEMONSTRATION (CAPTIDE)
Costabile, Gregg D., Department of the Air Force, USA; Fowler, Jesse, Department of the Air Force, USA; Elbert, Timothy, Department of the Air Force, USA; Reiter, David, III, Department of the Air Force, USA; Jun. 1996; 8p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper presents a discussion and results of a flight test to obtain time, space, position information (TSPI) using a carrier phase (or kinematic) global positioning system (GPS). A carrier phase capable GPS receiver was installed on board an F-16 aircraft and flown in conjunction with an inertial navigation system (INS)/differential GPS guided weapon test program. The carrier phase TSPI data was compared to the position solution from existing test range TSPI sources, including: four high dynamic Contraves cinetheodilites operated at 30 frames per second, two FPS-16 radars, the aircraft position system solution, an INS/GPS position measurement pod on board the

aircraft, and a post-mission Kalman smoother based software algorithm called 'test data optimal processor'. The carrier phase and and test range solutions were also compared to the INS/differential global positioning system (DPGS) test items. A series of aircraft maneuvers were conducted to collect truth data to compare the carrier phase GPS position with the 'truth' position. This was the first experiment known to the authors which utilized the carrier phase observable in an aircraft environment where high accuracy TSPI was available to evaluate the accuracy of the carrier phase technology.
Author
Aircraft Maneuvers; F-16 Aircraft; Flight Tests; Global Positioning System; Inertial Navigation; Accuracy; Position (Location)

19960053052 Aeronautical Systems Div., Eglin AFB, FL United States
EXPLOITATION OF DIFFERENTIAL GPS FOR GUIDANCE ENHANCEMENT (EDGE) HIGH GEAR PROGRAM
Dargan, John L., Aeronautical Systems Div., USA; Howell, Gary, Aeronautical Systems Div., USA; Elbert, Tim, Aeronautical Systems Div., USA; Gaskill, David, Aeronautical Systems Div., USA; Jun. 1996; 12p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

On May 23, 1995, an F-16 dropped a modified GBU-15 incorporating a differentially corrected inertial navigation system/global positioning system (INS/GPS) to successfully attack a vertical target. The GU-15 impacted within 2 meters of the target. The exploitation of differential GPS for guidance enhancement (EDGE) program allows streamlined acquisition and reporting procedures for adding a precision capability to baseline GPS-guided munitions. The EDGE program objective was to demonstrate the navigational accuracy improvement potential of differential GPS (DGPS) for guiding air-to-ground munitions through an end-to-end weapon system implementation of DGPS. Results show that precision navigation accuracy is attainable through DGPS. This paper provides details on the EDGE system implementation and the results from ground, captive, and free-flight tests.
Derived from text
Global Positioning System; Inertial Navigation; Captive Tests; Flight Tests; Precision Guided Projectiles; Bombs (Ordnance)

19960053055 Societe de Fabrication d'Instruments de Mesure, Massy, France
NAVIGATION WITHOUT INITIALIZATION OF AN INERTIALLY GUIDED BOMB *NAVIGATION SANS INITIALISATION D'UNE BOMBE GUIDEE INERTIELLEMENT*
Paturel, Yves, Societe de Fabrication d'Instruments de Mesure, France; Martin, Eric, Societe de Fabrication d'Instruments de Mesure, France; Audren, Jean-Thierry, Societe de Fabrication d'Instruments de Mesure, France; Technologies for Precision Air Strike Operations in Rapid-Reaction and Localized-Conflict Scenarios; Jun. 1996; 10p; In French; See also 19960053042; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The range of traditional guided bombs is limited to 4 to 6 kilometers depending on the firing conditions. The sophistication of air defences makes bombing missions more and more dangerous for pilots and their aircraft. The use of propelled bombs allows one to increase the range of bombs and therefore to ensure better mission safety. Obtaining accurate precision requires a means of guidance of which the most secure and most independent is inertial guidance. However, such guidance requires initialization of the inertial fusing of the bomb and there fore the supply of data from the aircraft to the bomb (speed, position). This constraint was expensive for earlier models of aircraft for which the numerical data links do not reach the inertial points of the bombs. This article succinctly describes a new technique which allows one to drop a propelled bomb, and guid it with out initializing the inertial mechanism. An analysis of performance features of the process was simulated as well as an analysis of the sensitivity to different error sources. The modifications required for aircraft flight control are described.
Author
Aircraft Control; Data Links; Bombs (Ordnance); Guidance (Motion); Position (Location)

19960053056 Sverdrup Technology, Inc., TEAS Group, Eglin AFB, FL United States
ANALYSIS OF DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS) TECHNIQUES AND GPS JAMMING ON PRECISION GUIDED MUNITION (PGM) PERFORMANCE
Mahmood, Sultan, Sverdrup Technology, Inc., USA; Solomon, Joseph, Sverdrup Technology, Inc., USA; James, Rick, Sverdrup Technology, Inc., USA; Lawrence, Danny, Sverdrup Technology, Inc., USA; Technologies for Precision Air Strike Operations in Rapid-Reaction and Localized-Conflict Scenarios; Jun. 1996; 10p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Differential global positioning system (DGPS) adaptive filtering and anti-jam techniques are being evaluated to enhance the accuracy of the weapon in adverse weather as well as to reduce is susceptibility ot electronic countermeasures (ECM). This paper provides a comparison of two candidate DGPS techniques and their associated error budgets.
Derived from text
Adaptive Filters; Electronic Countermeasures; Jamming; Global Positioning System; Precision Guided Projectiles; Inertial Navigation; Weather

19970014117 Boeing Commercial Airplane Co., Air Traffic Management Research, Seattle, WA United States
A SIMULATION-BASED STUDY OF THE IMPACT OF AIRCRAFT WAKE TURBULENCE WEIGHT CATEGORIES ON AIRPORT CAPACITY
Robinson, Jerry J., Boeing Commercial Airplane Co., USA; Nov. 1996; 16p; In English; See also 19970014096; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Federal Aviation Administration (FAA) is considering revising the current aircraft wake turbulence weight categories and the associated separation standards during instrument meteorological conditions (IMC). Various proposals have been submitted to the FAA with regard to this revision. This paper presents the results and conclusions of a capacity study conducted by The Boeing Company. This study examined the impact of these proposed changes on airport capacity during IMC. The approach taken for this study was to simulate arrival and departure operations at ten major US airports by employing a database derived from the 1993 Official Airline Guide (OAG) traffic schedule. Simulations were conducted for the traffic mix at each airport utilizing one standard, representative runway configuration. The aircraft wake vortex separation requirements were changed according to the various proposed weight categories; these separations were then applied to the particular traffic set at each airport. In general, it was found that current capacity levels could be reduced by as much as 4%. This approach provides a consistent comparison of capacity results. It is hoped that the results from this study will provide useful information to assist in assessing the capacity impact of a modification to the existing aircraft wake turbulence weight categories and their associated separation standards during IMC.
Author
Aircraft Wakes; Air Traffic; Traffic; Turbulence; Vortices

19970014118 NASA Langley Research Center, Hampton, VA United States
AN AIRCRAFT VORTEX SPACING SYSTEM (AVOSS) FOR DYNAMICAL WAKE VORTEX SPACING CRITERIA
Hinton, D. A., NASA Langley Research Center, USA; Nov. 1996; 12p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A concept is presented for the development and implementation of a prototype Aircraft Vortex Spacing System (AVOSS). The purpose of the AVOSS is to use current and short-term predictions of the atmospheric state in approach and departure corridors to provide, to ATC facilities, dynamical weather dependent separation criteria with adequate stability and lead time for use in establishing arrival scheduling. The AVOSS will accomplish this task through a combination of wake vortex transport and decay predictions, weather state knowledge, defined aircraft operational procedures and corridors, and wake

vortex safety sensors. Work is currently underway to address the critical disciplines and knowledge needs so as to implement and demonstrate a prototype AVOSS in the 1999/2000 time frame.
Author
Aircraft Wakes; Air Traffic Control; Vortices; Safety

19970014308 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
PRECISION TERMINAL GUIDANCE FOR MUNITIONS ***LE GUIDAGE TERMINAL PRECIS POUR LES MUNITIONS***
Feb. 1997; 136p; In English
Report No.(s): AGARD-AR-342; ISBN 92-836-1048-2; Copyright Waived; Avail: CASI; A07, Hardcopy; A02, Microfiche

The effectiveness of the guided munitions used in that conflict emphasized their importance in 'conventional' warfare. Following this experience, the lessons learned from military interventions by NATO nations has often yielded less clear-cut results. In spite of these recent events, it seems clear that the future of precision guidance is assured, for reasons similar to those prevailing during the Gulf War, that is, their usefulness as a 'force multiplier'. This enables them to: maximize the effective fire power of launch platforms; minimize the number of missions required to carry out a given task; and reduce collateral damage to non-combattants to a minimum. The Working Group oriented its aims towards NATO military needs and the review of terminal guidance technology in relation to those needs, using the two following items as a starting point: the AGARD planning guidelines, which give a top-down view, derived from the NATO strategic concept; an analysis by GCP of the implications of the Gulf War for guidance and control. The review of terminal guidance technologies was also aimed at identifying new capabilities not currently part of NATO's armory. Projections into the future often produce speculative concepts that, in the light of deeper study, turn out to be unworkable, unaffordable or even misguided. But new ideas, however impractical at first sight, are the stimulus NATO needs to stay at the forefront of technology advances.
Author (revised)
Terminal Guidance; Bombs (Ordnance); Weapon Systems; Military Technology

19970018633 Norwegian Defence Research Establishment, Div. for Electronics, Kjeller, Norway
A NAVIGATION SYSTEM CONCEPT FOR A MODERN ANTI-SHIP MISSILE
Hoelsaeter, O., Norwegian Defence Research Establishment, Norway; Jalving, B., Norwegian Defence Research Establishment, Norway; Nov. 1996; 12p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A navigation system concept for a modern anti-ship missile has been investigated. The navigation system can be divided into several subsystems. At open sea, altitude measurements are used in a Kalman filter to limit the inertial navigation system (INS) error propagation. Correspondingly, terrain contour matching (TERCOM) position updates are used when flying over land. A method for estimating the sea state and predicting extreme wave heights, which is useful in choosing sea skimming altitude, is also discussed. Finally, a model based compensator, which reduces dynamic errors of the INS attitude references used for for seeker stabilization, is described. The paper presents the theory of the various subsystems and how they are integrated. Results from tests with real data as well as simulations are presented.
Author
Air to Surface Missiles; Inertial Navigation; Kalman Filters; Sea States; Computerized Simulation

19970026432 Advanced Research Projects Agency, Tactical Technology Office, Arlington, VA United States
RESULTS OF GLOBAL POSITIONING SYSTEM GUIDANCE PACKAGE (GGP) TECHNOLOGY DEMONSTRATION
Kaspar, B., Air Force Systems Command, Bolling AFB, USA; Aein, J., RAND Corp., USA; Killen, A., Army Missile Command, USA; Dahlen, N., Litton Guidance and Control Systems, USA; Jun. 1997; 12p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Advanced Research Projects Agency (ARPA) began a program in May 1983 to demonstrate the necessary solid-state technologies to miniaturize full military precision (P/Y) GPS receivers. The 'Virginia Slims' miniature GPS receiver (MGR) program was successfully completed in December 1989 with the demonstration of an MGR the size of a cigarette package. Military products derived from the 'Virginia Slims' MGR chip set include the Tomahawk Land Attack Missile GPS receiver, the Precision Location GPS Receiver (PLGR), and the Miniature Airborne GPS Receiver (MAGR), as well as several commercial GPS engines.
Derived from text
Global Positioning System; Miniaturization; Chips (Electronics); Integrated Circuits

19980016582 Draper (Charles Stark) Lab., Inc., Director, Guidance Technology Center, Cambridge, MA United States
HIGH INTEGRITY GLOBAL PRECISION NAVIGATION SYSTEMS
Schmidt, George T., Draper (Charles Stark) Lab., Inc., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 16p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper will focus on the technology trends for (1) inertial sensors, (2) GPS accuracies, and (3) integrated GPS/INS systems, including considerations of jamming, for military platforms and weapons, that will lead to the high integrity, one meter accuracy global precision navigation systems of the future. For inertial sensors, trend-setting sensor technologies applicable to military systems will be described. They are: fiber-optic gyros, silicon micromechanical gyros, resonating beam accelerometers, and silicon micromechanical accelerometers. A vision of the inertial sensor instrument field, and inertial systems for military applications for the next few decades will be given. GPS specified and observed current accuracies will be described, as well as, planned accuracy improvements due to various stages of the WAGE implementation, inter-satellite ranging, and "all-in-view" tracking. Uses of relative and differential GPS will be discussed. The trend towards tightly-coupled GPS/INS, where both code and carrier tracking loops are aided with inertial sensor information, will be described and the synergistic benefits explored. Some examples of the effects of jamming will be described and expected technology trends to improve system anti-jam capability will be presented.
Author
Global Positioning System; Inertial Navigation; Jamming; Gyroscopes; Military Technology; Inertial Platforms

19980035006 Centre d'Essais en Vol, Base d'Essais d'Istres, Istres, France
SYTRAM (SYSTEME DE TRAJECTOGRAPHIE MULTIMOBILE): A NEW GUIDANCE METHOD FOR TEST OF MULTITARGET AIRPLANES ***SYTRAM (SYSTEME DE TRAJECTOGRAPHIE MULTIMOBILE): UNE NOUVELLE METHODE DE GUIDAGE DES AVIONS POUR LES ESSAIS MULTI-CIBLES***
DeMalleray, E., Centre d'Essais en Vol, France; Advances in Flight Testing; Dec. 1997; 16p; In French; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

SYTRAM has been developed based on a need by CEV (Centre d'Essais en Vol) to have an autonomous and precise guidance system for multi target testing. The multi target tests often require the development of precise scenarios that are difficult and even impossible without a high quality and continuous guidance system. Until now, these tests have been conducted with the assistance of guidance systems on the ground, transmitting their orders via radio. They can only follow one airplane with precision, and up to a maximum of 4 airplanes. Beyond that, several guiding systems would be necessary, but the radio would be saturated. SYTRAM is an ascending and descending liaison. The ascending liaison (60 KBIT/sec) of the system SYTRAM allows the conception of a function, named "Autonomous Guidance" which will produce guidance information to the equipment being tested, for autonomous installation, i.e. without the use of radiotelegraphy. Four guidance interfaces have been developed, the HUD, the HDD, and the Classic and Audio Instrumentations. The guidance law, common to all interfaces, was completed in the simulator in 3 weeks. In flight tests started with 3 flights on the ABE Mystere XX. The goal of these tests was to confirm the feasibility of the autonomous guidance function. The interface HDD was chosen for the tests but the capacity to modify the coefficients of the law of in-flight navigation was preserved. Finally, the application of the HDD symbology is under development on a liquid crystal screen.
Author
Flight Tests; Autonomy; Navigation

19980035007 Instituto Superior Tecnico, Lisbon, Portugal
EUROPEAN FLIGHT EXPERIMENTS ON 4-DIMENSIONAL APPROACH AND LANDING WITH THE CASA 212 AVIOCAR AIRCRAFT
Azinheira, J. R. C., Instituto Superior Tecnico, Portugal; Fonseca, A. A., Instituto Superior Tecnico, Portugal; Avello, C. Garcia, European Organization for the Safety of Air Navigation, Belgium; Swierstra, S., European Organization for the Safety of Air Navigation, Belgium; Advances in Flight Testing; Dec. 1997; 10p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Over the years a continuing increase in demand for air travel was observed that always surpassed the highest estimates. The capacity limit of the major airports constitutes one of the bottlenecks in the expansion of air transport. In order to maintain a competitive edge, air carriers use aircraft types that offer optimum economy on the routes they fly. In a typical hub operation, this results in a mixture of jet, turboprop and prop aircraft, each with a different operational speed range. Today for the main airports, the runway constitutes a major bottleneck. Accordingly the optimisation of the capacity of an airport becomes a very complex task when the stream of inbound aircraft consists of a mixture of aircraft types. The introduction of automated tools to enhance the efficiency of the air traffic controllers is one of the targets of the EATCHIP programme to improve the overall quality of the air traffic control services provided . Research programmes have led to the development of such tools, in particular to assist the air traffic controllers with the problem of optimum Arrivals Management. Meanwhile these tools have been tested and initially validated in simulation environments. The requirement existed to test and demonstrate algorithms developed using a real aircraft, initially in an isolated, well-controlled flight environment. This has led the EUROCONTROL Agency (EHQ, Brussels) and the Instituto Superior Tecnico (IST, Lisbon) to organize in close co-operation with Aeroportos e Navegacao Aerea (ANA, Lisbon) and Montijo) a live exercise to investigate the feasibility and performance of such a tool. This report describes the flight trials and some of the conclusions drawn. The references at the end of this text give a detail explanation of the different components that were used to perform these trials.
Author
Air Transportation; Airports; Air Traffic Control; Flight Control

19980035009 Technische Univ., Inst. of Flight Guidance, Brunswick, Germany
ENSURING THE GNSS ONBOARD INTEGRITY FUNCTION UNDER ADVERSE CONDITIONS: FEASIBILITY AND FLIGHT TEST RESULTS
Butzmuehlen, Carsten, Technische Univ., Germany; Dec. 1997; 10p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

With an increasing system and technology performance of satellite navigation components, the Global Navigation Satellite Systems (GNSS) conquer more and more fields of military and civil applications. Due to the undisputed high level of accuracy and its marginal needs of terrestrial infrastructure, satellite navigation is in principle the most suitable candidate for positioning tasks under adverse environments where conventional radio navigation aids fail. Considering this background, the Institute of Flight Guidance and Control participated recently in a flight test program in Lugano, Switzerland supported by the Swiss Federal Office of Aviation (FOCA). Flight tests were performed under highly dynamic and adverse conditions with the additional use of low-cost inertial information. The landscape in which these test were realized leads to the risk of extensive shadowing of the space vehicles, thus increasing the probability that the GNSS is not available in order to compute a position solution. Additionally, the mountains provide a reflecting surface of the radio frequency signals. Hence, the possibility of multipath reception is given here as well. This paper deals with the current means that are used to achieve the accuracy and the integrity that is necessary for high-precision and safety-critical procedures. The methods are discussed briefly and flight test results are presented.
Author
Feasibility; Flight Tests; Data Acquisition; Navigation Satellites; Navigation Aids

19980035018 National Research Council of Canada, Research Test Pilot, Ottawa, Ontario Canada
PERFORMANCE AND GUIDANCE SYSTEM TESTING USING DIFFERENTIAL GPS ON A FALCON 20 AIRCRAFT
Croll, John B., National Research Council of Canada, Canada; Advances in Flight Testing; Dec. 1997; 8p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Using a Falcon 20 research aircraft, a program was conducted at the Canadian National Research Council (CNRC) to investigate the use of a differential Global Positioning System (GPS) to: (1) provide aircraft guidance on precision instrument approaches, and (2) measure aircraft performance parameters during typical flight test manoeuvres needed for aircraft certification. The initial series of tests used a differential GPS with NovAtel 95 IR receivers installed in the aircraft and at the ground station, and with a VHF radio link to provide real-time differential corrections. This system fell slightly short of the vertical accuracy criteria needed for precision approaches to Category I limits, and did not meet the accuracy criteria desired for flight test measurement. Following an upgrade to a NovAtel RT-20(trademark) differential GPS, a program was conducted to determine the landing performance of the Falcon 20 on winter contaminated runways (covered with ice or snow). The real-time position and height accuracies of the upgraded system were determined to be less than 20 centimeters, falling well within the accuracy criteria for Category I approaches, and enabling this system to be used as the primary device for measuring aircraft landing distances from a height of 50 feet (15 meters) to a complete stop. During this program, a strong correlation was found between aircraft deceleration during full braking and the runway friction index reported by a ground test vehicle, allowing the aircraft landing distance to be accurately predicted as a function of the runway friction index.
Author
Aircraft Guidance; Aircraft Performance; Certification; Correction; Flight Tests; Ground Tests; Instrument Approach

19980035019 Technische Univ., Inst. of Flight Mechanics and Flight Control, Munich, Germany
PRECISION NAVIGATION AND SYNTHETIC VISION FOR POOR VISIBILITY GUIDANCE
Sachs, G., Technische Univ., Germany; Dobler, K., Technische Univ., Germany; Schaenzer, G., Technische Univ., Germany; Dieroff, M., Technische Univ., Germany; Dec. 1997; 12p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Computer generated synthetic vision is considered as a means for providing guidance in poor visibility conditions. The synthetic vision comprises as basic elements a 3-dimensional image of the outside world and integrated guidance information like a tunnel display. A precision navigation system is applied which couples differential satellite and inertial sensor data to achieve the required high performance. A flight test program was conceived to cover a wide range of synthetic vision guidance applications (precision approach and landing, low level flight in narrow river valley, curved/steep/short approaches and terrain following in mountainous areas). Four test series at different areas were conducted. The results of the flight test program show that the synthetic vision enables the pilot to precisely control the aircraft. He successfully performed the flight tasks.
Author
Visual Control; Navigation; Precision; Flight Tests; Display Devices

19980035020 National Research Council of Canada, Flight Research Lab., Ottawa, Ontario Canada
VALIDATION OF THE SIMULTANEOUS CALIBRATION OF AIRCRAFT POSITION ERROR AND AIRFLOW ANGLES USING A DIFFERENTIAL GPS TECHNIQUE ON A HELICOPTER
Hui, Kenneth, National Research Council of Canada, Canada; Baillie, Stewart, National Research Council of Canada, Canada; Dec. 1997; 8p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes the validation of a technique for the simultaneous determination of pitot-static position error and the calibration curves for angle of attack and sideslip sensors. The Simultaneous Calibration of AirData system (SCADS) technique involves flying the aircraft in a 'wind box' pattern while recording a suite of standard flight test parameters and Differential Global Positioning System (DGPS)

measurements. This simultaneous calibration technique combines the calibration procedure for both position error and airflow angle calibration, and eliminates the need for flying close to the ground during the tests. During the development of this technique using the NRC Falcon 20 aircraft, the results demonstrated that accurate calibrations could be obtained with reduced flight time and cost over conventional calibration techniques. The present paper describes the application of the SCADS technique to the NRC Bell 206B helicopter. The calibration results are presented and are compared with data from other standard calibration methods and verified with manoeuvres not used in the model development. The results from using the SCADS technique have demonstrated better efficiency and accuracy.
Author
Calibrating; Position Errors; Angle of Attack; Bell Aircraft; Proving

19980201657 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
AIR TRAFFIC MANAGEMENT: SUPPORT FOR DECISION MAKING OPTIMISATION - AUTOMATION *LA GESTION DU TRAFFIC AERIEN AIDE A LA DECISION OPTIMISATION - AUTOMATION*
Benoit, Andre, Editor, European Organization for the Safety of Air Navigation, Belgium; Air Traffic Management: Support for Decision Making Optimization - Automation; Dec. 1997; 284p; In English; The Mission Systems Panel Workshop on ATM, 27-29 May 1997, Budapest, Hungary; See also 19980201658 through 19980201677
Report No.(s): AGARD-R-825; ISBN 92-836-1064-4; Copyright Waived; Avail: CASI; A13, Hardcopy; A03, Microfiche

As a contribution to the increasing cooperation between NATO and former Warsaw Pact countries, the Mission Systems Panel of AGARD organized a Workshop on Air Traffic Management, held in Budapest, Hungary on 27-29 May 1997. Emphasis was placed on the fundamentals of air traffic handling and an effort was made to establish a fruitful dialogue between experienced experts and young mathematicians, physicists and engineers, offering a fresh approach to the on-line conduct of traffic management. The main characteristics of Air Traffic Handling were outlined; it is a large-scale, international, multi-disciplinary and complex system. The aircraft, the basic element of air traffic, was given considerable consideration: the manner in which it is flown and its dynamics, the potential role of the on-board flight management system, the current and expected level of automation, and the advent of unmanned military aircraft. Could Air Traffic Handling become a discipline in itself as part of the academic subject of aerospace? What assistance could be made available to the human controller in the present types of operation? Finally, if it was intended to make major improvements to the management of all flights, what optimization techniques were suitable for on-line operations? These important questions were debated in a session devoted to the fundamentals of air traffic management. An attempt was then made to illustrate some trends in the optimization and automation processes: arrivals management in the PHARE programme; application of genetic algorithms to mid-air collision avoidance; the detection and resolution of conflicts using coupled force field techniques and a broad look at global traffic optimization. Plans and prospectives were presented: human-machine interface in the Hungarian MATIAS project; a US view of the situation as seen by the FAA; the CNS/ATM concept as an ICAO prospective and the EATCHIP-EATMS concept offered as a European perspective. The Round Table which ended the meeting offered strong encouragement to the academic and scientific communities to inform their members of the nature, complexity and interest of the problems - numerous and varied - raised by the need to improve the presently critical air traffic situation. Examples of outstanding doctoral dissertations were included in this Workshop programme.
Author
Flight Management Systems; Air Traffic Control; Flight Plans; Flight Optimization; Automatic Flight Control; Dynamic Control

19980201658 European Organization for the Safety of Air Navigation, EUROCONTROL, Brussels, Belgium
DYNAMIC CONTROL OF AIR TRAFFIC: CRITERIA - CONTROL VARIABLES - CONSTRAINTS
Benoit, Andre, European Organization for the Safety of Air Navigation, Belgium; Air Traffic Management: Support for Decision Making Optimization - Automation; Dec. 1997; 2p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

In a recent presentation, Dominique Colin de Verdiere considered which areas of air traffic handling need to be optimized. The question is not only pertinent, but must be answered if we are to meet with the intention of turning our attention to the same areas. Several optimization and automation aspects will be discussed in the course of this workshop. In this general introduction, the intention is simply to outline some essential and basic problems concerning the conduct of air traffic.
Derived from text
Dynamic Control; Automatic Flight Control; Automatic Landing Control; Air Traffic Control

19980201659 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Flight Guidance, Brunswick, Germany
DYNAMIC CONTROL OF GROUND MOVEMENTS: STATE-OF-THE-ART REVIEW AND PERSPECTIVES
Voelckers, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Boehme, D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Dec. 1997; 12p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Air Traffic Management is a very complex and challenging domain. to cope with future traffic demand, while still maintaining or even increasing safety and efficiency of air traffic operations, intelligent machine functions have to be developed to assist the human operators in their mental control tasks. The specific requirements of the ATM domain necessitate sophisticated and well-designed assistance tools. Their most significant characteristics, design principles and structures are discussed and exemplified in a real-world application.
Author
Air Traffic Control; Dynamic Control; Flight Plans; Man Machine Systems; Flight Optimization

19980201660 Warwick Univ., Operational Research and Systems Group, Coventry, United Kingdom
ATFM: OPTIMISATION APPROACHES
Matos, Paula, Warwick Univ., UK; Dec. 1997; 20p; In English; See also 19980201657; Sponsored in part by Ciencia e Tecnologia.; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

European centralized air traffic flow management (ATFM) is still in its early stages of development and has urgent and extensive needs in terms of decision support tools. This paper provides a brief overview of research in ATFM and discusses the feasibility of optimization approaches to European ATFM. Three optimization models for re-routing air traffic flows and their test results are presented and analyzed.
Author
Air Traffic Control; Flight Paths; Air Traffic; Routes

19980201662 Smiths Industries Aerospace and Defence Systems Ltd., Cheltenham, United Kingdom
FLIGHT MANAGEMENT SYSTEMS IN THE NEW AIR TRAFFIC MANAGEMENT (ATM) ENVIRONMENT
Meredith, J. F., Smiths Industries Aerospace and Defence Systems Ltd., UK; Air Traffic Management: Support for Decision Making Optimisation - Automation; Dec. 1997; 10p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The new ATM environment will place additional requirements on Flight Management Systems. It will be necessary to provide data on position and aircraft trajectory to be used by other aircraft and by ground based air traffic managers, at a level of availability and integrity which is consistent with the safety of the air traffic system. Corresponding data from the other aircraft in the airspace must be analyzed in order to identify potential conflicts. The algorithms for the resolution of potential conflict with other aircraft must be based on a common strategy which applies throughout all aircraft. The way in which such conflict resolution could interface with the FMS flight plan and with optimization are discussed.
Author
Flight Management Systems; Air Traffic Control; Flight Optimization; Flight Plans

19980201663 Academie Nationale de l'Air et de l'Espace, Toulouse, France
IMPACT OF AUTOMATION ON THE OPTIMISATION OF THE FLIGHT
Pelegrin, Marc, Academie Nationale de l'Air et de l'Espace, France; Air Traffic Management: Support for Decision Making Optimization - Automation; Dec. 1997; 12p; In English; See also 19980201657; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The presentation encompasses the following topics regarding flight automation: (1) traffic growth; (2) major technical events in the near future; (3) keywords (terminology); (4) direct impact of automation on safety of the flight; (5) efficiency; (6) pollution control; and finally (7) report synthesis and conclusions.
CASI
Flight Optimization; Automatic Flight Control; Air Traffic; Flight Safety

19980201665 Massachusetts Inst. of Tech., Dept. of Aeronautics and Astronautics, Cambridge, MA United States
ATM AS PART OF THE AEROSPACE ENGINEERING CURRICULUM
Simpson, Robert W., Massachusetts Inst. of Tech., USA; Dec. 1997; 4p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The problems of changing the traditional aerospace engineering curriculum to provide an education for young engineers interested in developing the new forms of ATM (air traffic management) systems is discussed. The new ATM systems will introduce quite different concepts for operational procedures and a much higher level of traffic handling performance using new technologies for communications, navigation, and surveillance identified by the FANS Committee of ICAO, and will introduce digital datalink and automated decision support processes in the cockpit and at the AT controller's console. It is concluded that subjects in human factors and operations research pertinent to ATM operations are badly needed, and that there is not enough time in the normal curriculum to teach all necessary subjects for a completely qualified ATM project engineer so that short courses are needed for engineers from industry to prepare them for this responsibility.
Author
Education; Aerospace Engineering; Flight Management Systems; Air Traffic Control; Human Factors Engineering

19980201666 Air Traffic and Airport Administration, Area Control Centre, Budapest, Hungary
AIRSPACE ORGANISATION AND OPTIMISATION
Mavrak, Gabor, Air Traffic and Airport Administration, Hungary; Air Traffic Management: Support for Decision Making Optimization - Automation; Dec. 1997; 18p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The evolution of airspace organization and optimization from the early 1970's to the early 1990's is presented. Special emphasis is given to Hungarian involvement and its peculiarities. Airspace classification, the ATS delegations, dynamic management (strategic planning, pre-tactical planning and the tactical phase), and ongoing projects are considered.
CASI
Management Planning; Airspace; Classifications; Air Traffic

19980201667 European Organization for the Safety of Air Navigation, Brussels, Belgium
HUMAN ROLE IN ATM: SUPPORT FOR DECISION MAKING
Garcia-Avello, Carlos, European Organization for the Safety of Air Navigation, Belgium; Swierstra, Sip, European Organization for the Safety of Air Navigation, Belgium; Dec. 1997; 12p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The ever increasing demand for air traffic is silting up the Air Traffic control system. As a response, the high level management moves towards a business approach: increase system capacity to meet the demand, monitor the quality of the product, in particular safety, and reduce the cost. Air Traffic Control is a complex task that involves human controllers and machines. Today, there is a consensus such that, at least in the enroute environment, the human controller is a major bottle-neck. Accordingly, the introduction of a higher level of automation is considered to be the way forward. The EATCHIP program of Eurocontrol, in close cooperation with its member states is defining the EATCHIP Phase III ATC system generation that aims to improve ATC capacity and flight economy whilst at least maintaining the present safety level. It intends to achieve this by introducing automation in a human-centered approach. The paper describes some human characteristics related to the introduction of automation in general, current trends in future system automation and associated safety risks. The paper concludes with a proposal for a pragmatic way ahead including how to gain controller acceptance.
Author
Air Traffic Control; Human Performance; Human Factors Engineering; Decision Making; Management Systems; Air Traffic Controllers (Personnel)

19980201668 Centre d'Etudes et de Recherches, Toulouse, France
OPTIMIZATION TECHNIQUES AS AVAILABLE FOR ON-LINE OPERATIONS
Imbert, Nicole, Centre d'Etudes et de Recherches, France; Farges, Jean Loup, Centre d'Etudes et de Recherches, France; Dec. 1997; 18p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In the frame of this workshop dedicated to support for decision making optimization and automation, it appeared useful to the organizing team to include a general presentation of what optimization means and of the various existing methods to solve optimization problems. In this paper we will try to classify the optimization techniques according to the type of problems they are intended to solve and to the type of solutions that may be expected for each of them. We do not try to solve exhaustively as we are more concerned with the general methodologies. In fact many methods exist. For all types of methods, adaptations and improvements have been developed in order to increase their efficiency, their rate of convergence or decrease computing time. For specific applications, the best results are often obtained from the combination of several algorithms. In taking advantage of the specificity of each, efficient methods are then obtained.
Author
On-Line Systems; Decision Making; Mathematical Programming; Mathematical Models

19980201669 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugfuehrung, Brunswick, Germany
PHARE DEMONSTRATION: ARRIVALS MANAGEMENT
Reichmuth, Johannes, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Dec. 1997; 12p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper reports first results obtained from the real-time simulations in the frame of the second PHARE Demonstration (PD/2) performed during December 1996 to February 1997 at DLR in Brunswick. The experimental set-up of three different configurations for the management of arrivals in an extended TMA airspace using the Tools developed within the PHARE program in connection with DLRs Air Traffic Management and Operations Simulator (ATMOS) is described. A conventional arrival management system is compared with advanced arrival management based on time accurate trajectory predictions provided from ground as well as from the air. An overview on the advanced Ground Human Machine Interface developed for these experiments is given. Eight controller teams from seven European countries take part on the experiment. The first analysis of the collected data in terms of performance, workload and acceptance supports the ideas of the presented operational concepts for the Approach problem further to be included within future Air Traffic Management Systems.
Author
Flight Management Systems; Air Traffic Control; Arrivals; Air Traffic; Flight Paths; Trajectory Planning; Approach Control

19980201670 Centre d'Etudes de la Navigation Aerienne, Lab. d'Optimisation Globale, Toulouse, France
OPTIMAL RESOLUTION OF EN ROUTE CONFLICTS
Durand, Nicolas, Centre d'Etudes de la Navigation Aerienne, France; Alliot, Jean-Marc, Centre d'Etudes de la Navigation Aerienne, France; Dec. 1997; 12p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Automatic control has been a subject of studies for the last twenty years. It involves many difficult problems that have to be solved:

conflict detection, modelling of uncertainties on trajectories, clustering of 1-to-1 conflict to find unconnected n-aircraft problems, etc... Moreover, the n-aircraft conflict resolution problem is highly combinatorial and cannot be optimally solved using classical mathematical optimization techniques. The set of admissible solutions is made of many unconnected subsets enclosing different local optima, but the subset enclosing the optimum cannot be found a priori. In this paper, we present an automatic conflict solver and its implementation in an air traffic simulator, with statistical results on real traffic over France. This solver, which takes into account speed uncertainties and allows aircraft to fly on direct routes, solves every conflict on a loaded day, and gives each aircraft its requested flight level and departure time.
Author
Automatic Flight Control; Simulators; Routes; Air Traffic; Flight Management Systems; Optimization; Real Time Operation; Mathematical Models; Control Simulation

19980201671 Global Air Traffic Management, Athens, Greece
GLOBAL AIR TRAFFIC MANAGEMENT (GATM)
Trivizas, Dionyssios A., Global Air Traffic Management, Greece; Dec. 1997; 12p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The paper describes concepts that relate to Global Air Traffic Management(GATM) emphasizing the potential of mathematical modeling and behavioral simulation in creating a flexible and efficient traffic management system. These concepts include design methodology, flow management, airspace structure and optimal runway scheduling. They reflect the author's theoretical study and experience on the subject of Air Traffic Control, combining knowledge and ideas from related large scale optimal dynamic resource allocation problems encountered in military logistics, transportation and economics. The resource in question is the airspace-time and the paper discusses alternative ways, such as the space-time market, for sharing it in a safe, expedient and cost effective way. The paper concludes with optimal runway capacity results for the two major airports of Frankfurt and Chicago O'Hare.
Author
Air Traffic Control; Management Systems; Mathematical Models; Resource Allocation; Space-Time Functions; Scheduling; Operations Research; Dynamic Programming; Stochastic Processes

19980201672 Global Air Traffic Management, Athens, Greece
OPTIMAL SCHEDULING WITH MAXIMUM POSITION SHIFT (MPS) CONSTRAINTS: A RUNWAY SCHEDULING APPLICATION
Trivizas, Dionyssios A., Global Air Traffic Management, Greece; Dec. 1997; 10p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The airport's runway system may be viewed as a queueing system where a stream of flights is waiting to receive take-off or landing "service". It has been observed that changing the order of runway operations results in a different runway throughput or "capacity". This is due to wake vortex considerations, whereby the minimum horizontal separations between successive landing aircraft depends on their weight and final approach speed. This observation gave rise to the Optimal Runway Scheduling Problem (RSP) that seeks to find the optimal rearrangement of flights that would maximize runway throughput. RSP is complicated by the fact that in a real time system, where flights appear randomly over time, there is always a possibility of some flight being indefinitely displaced backwards in the queue. This calls for the Maximum Position Shift (MPS) constraints which assure that no flight will be displaced in the queue by more than a pre-specified number k of positions. The term queue refers to the ordering of flights according to the First Come First Served (FCFS) discipline. The RSP is typical of queueing systems when service rate depends on customer ordering. It is also a variation of the notorious Traveling Salesman Problem (TSP). The paper presents the Parallel Dynamic Programming RSP algorithm, developed in Trivizas' doctoral dissertation. Timely solution is crucial to real time dynamic scheduling, and so the paper concentrates on its computational aspects. It is shown that the MPS constraints reduce the size of the problem's solution space, interpreted as a computational neighborhood around the FCFS sequence of "radius" equal to the MPS value. This neighborhood has the form of a permutation tree (PT). It is shown here that traversing the PT using a Branch and Bound (BB) Depth First Search, a brute force method, may require an amount of time which is exponential in the number n of customers (flights). It is further shown that the search may be organized efficiently using Breadth First Search Dynamic Programming which exploits the de-coupled, stage invariant solution space structure, whose size, 2(exp MPS)x n, is linear in n and exponential only in the bounded value of MPS. Stage invariance and label vector coding of the solution space allow for a generalized cross-section of the solution space; this leads to the concept of a parallel computation engine that sweeps the solution space in time linear in n.
Author
Programming (Scheduling); Dynamic Programming; Runways; Parallel Programming; Nonlinear Programming; Sequencing; Combinatorial Analysis; Air Traffic Control; Flight Management Systems

19980201673 Steria Automatisme et Ingenierie, Air Traffic Management Dept., Paris, France
AIRBORNE CONFLICT DETECTION AND RESOLUTION USING COUPLED FORCES FIELD TECHNIQUE: PRINCIPLES AND RESULTS
Zeghal, Karim, Steria Automatisme et Ingenierie, France; Dec. 1997; 12p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper presents an airborne conflict detection and resolution logic, based on the coupled forces field technique. This technique defines a general framework for decentralized and reactive coordination for mobile agents. An experiment has been carried out to evaluate this approach. The background, role of controllers and pilots, and what type of principles and the application of the technique to air traffic, as well as the principal results are presented.
Author
Air Traffic; Flight Management Systems; Coordination; Field Theory (Physics); Air Traffic Control

19980201674 Air Traffic and Airport Administration, Air Traffic Control Evaluation Unit, Budapest, Hungary
HUMAN-MACHINE INTERFACE (HMI) IN THE MAGYAR AUTOMATED AND INTEGRATED AIR TRAFFIC CONTROL SYSTEM (MATIAS)
Galantai, N., Air Traffic and Airport Administration, Hungary; Dec. 1997; 8p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Hungarian Air Traffic and Airport Administration is to replace the current Budapest Area Control Centre (ACC) with a new, purpose-built building at Ferihegy. The new ACC system is planned to be fully stripless and will include area control, terminal area control, aerodrome control, military control and flight information sectors. Readers involved in air traffic control may find it interesting how the system is planned to fulfill the controllers' requirements. The article contains the description of those functions, which are planned to be used by the operational staff in the OPS Room, so the technical and maintenance windows are omitted. The windows of the radio and telephone systems are also omitted.
Author
Air Traffic Control; Human-Computer Interface; Flight Management Systems; Windows (Computer Programs); Display Devices

19980201675 Federal Aviation Administration, Program Director for Research, Washington, DC United States
PLANS AND PERSPECTIVES FOR RESEARCH AND DEVELOPMENT IN AIR TRAFFIC MANAGEMENT
Miller, Clyde A., Federal Aviation Administration, USA; Dec. 1997; 16p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In 1993, the U.S. Congress passed the Government Performance and Results Act (GPRA). The purpose of the legislation is to improve Federal program effectiveness and public accountability by promoting a focus on results, service quality and customer satisfaction. The GPRA shifts the focus of program accountability from agency internal activities to the products and services planned to be placed in the hands of external customers and the eventual benefits to be achieved as a result. Decisions regarding expenditures of public funds will be justified in terms of these products, services and benefits. This perspective is very useful in planning and prioritizing research and development (R&D) projects in air traffic management (ATM). In particular, it would be useful to establish a comprehensive framework

of performance goals to guide R&D investments in ATM. Some progress toward this end has been achieved at the Federal Aviation Administration (FAA).
Author
Air Traffic Control; Flight Management Systems; Research and Development

19980201676 Direction de la Navigation Aerienne, Defense Nuclear Agency, Issy-les-Moulineaux, France
CNS/ATM CONCEPT: ICAO PROSPECTIVE
Dedryvere, A., Direction de la Navigation Aerienne, France; Carel, O., Direction de la Navigation Aerienne, France; Dec. 1997; 16p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In 1983, ICAO founded the FANS Committee (Future Air Navigation System) to trigger a global reflection on the radioelectric means to be used by Civil Aviation in 2000 and further. In dense areas (like the European core area between London, Paris, Milan, Berlin and Amsterdam) the growth of traffic will no more be manageable by the current control methods, ie. multiplying the number of sectors more and more. En-route and airport delays generate time and financial losses. In oceanic and desertic areas the traffic is low and will remain low for a long time. The lack of communication and navigation means generates large lateral and longitudinal separations which sometimes do not avoid near misses over continental crosspoints. There was a need for more reliable but affordable controller-to-controller and controller-to-pilot links associated with modern and reliable navigation aids. Aviation is generally famous for technical modernity but the International Maritime Organization was the first to implement a satellite communication system designed between 1976 and 1979 and put into operation on 01/02/1982. It was then possible for maritime crew and travelers to phone everywhere in the world, when aircraft pilots were unable to have a comfortable contact with ATC.
Author
Air Traffic Control; Air Navigation; Ground-Air-Ground Communication; Navigation Aids; Flight Management Systems

19980201677 European Organization for the Safety of Air Navigation, Experimental Centre, Bretigny-sur-Orge, France
THE WAY FORWARD, A EUROPEAN PERSPECTIVE
Fron, Xavier, European Organization for the Safety of Air Navigation, France; Dec. 1997; 24p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Some ideas about what may be coming next in European Air Traffic Management (ATM) are presented. More specifically, the following items will be discussed: (1) Why is there a need to act at all; (2) An attempt to explain existing plans in Europe to address challenges; and (3) to show that we have at least some idea of how to address those challenges, by presenting some results, which will lead us to a possible path forward, and finally to conclusions.
Derived from text
Air Traffic Control; Flight Management Systems; Management Planning; Europe

19980210664 Genoa Univ., Dept. of Biophysical and Electronic Engineering, Genoa, Italy
A KF-BASED INTEGRATION SYSTEM FOR LAND VEHICLE TRACKING FROM REAL DGPS AND INS DATA
Regazzoni, Carlo S., Genoa Univ., Italy; Teschioni, Andrea, Genoa Univ., Italy; Tacconi, Giorgio, Genoa Univ., Italy; Apr. 1998; 12p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The present work is addressed to perform an estimation in an accurate and robust way of the trajectory of a land vehicle by using a Differential Global Positioning System (DGPS) and an Inertial System (INS). The use of a Kalman Filter (KF) approach for integration, data-fusion and estimation tasks has been proved as able to providing precise and robust evaluation of cinematic variables (linear position and velocity) even in the case of long missions or under critical conditions of temporary incompleteness or unreliability of part of the acquired data. From the state of the art, it can be seen that the DGPS is very precise sensor providing 3D geographic position, but present low output rate and temporary signal loss or accuracy degradation, while the INS provides continuous outputs of rotation angles and linear acceleration with high output rate but the inertial units have burdensome intrinsic errors which bring about a degradation of precision increasing with time. Practically,the integration of DGPS and INS is forecast to provide continuous estimates over time, corrupted by small and almost unchanging errors. The system has been tested over an extensive set of real data providing good results both in precision and in robustness.
Author
Global Positioning System; Kalman Filters; Multisensor Fusion; Remote Sensing; Multisensor Applications

19990007855 Daimler-Benz Aerospace A.G., Military Aircraft, Ottobrunn, Germany
RELIABLE AUTONOMOUS PRECISE INTEGRATED NAVIGATION RAPIN FOR PRESENT AND FUTURE AIR-VEHICLES
Koehler, Thomas, Daimler-Benz Aerospace A.G., Germany; Tumbraegel, Franz, Daimler-Benz Aerospace A.G., Germany; Beyer, Juergen, Honeywell Regelsysteme G.m.b.H., Germany; Jul. 1998; 16p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The operation of unmanned vehicles ranging from strategic missions of autonomous high altitude reconnaissance to tactical missions of reconnaissance and strike/attack impose new requirements to the guidance systems in the area of reliability and safety. This includes all phases of the mission start, cruise, attack/strike and 'Low Level' operation including precision approaches,even under bad weather conditions and in a hostile environment. A reliable, continuous and precise navigation system is of paramount importance for the guidance function even more for unmanned air vehicles. The Project RAPIN, the name standing for 'Reliable Autonomous Precise Integrated Navigation', combines the navigational research activities at Daimler-Benz Aerospace AG (Dasa) Military Aircraft teamed with Honeywell Regelsysteme GmbH in that context. RAPIN integrates 'Laser Inertial Navigation System' (LINS), P(Y) code 'Global Positioning System' (GPS) and 'Terrain Referenced Navigation' system (TRN). The data fusion concept is to combine all available information in one MAIN filter gaining the highest accuracy. In order to provide uncontaminated backup solutions in case of sensor failures, a bank of SUB filters is working in parallel. Each SUB filter uses a different subset of sensor signals. It is the objective of this paper to report on the system concept, the design of the prototype, and to describe the realization process. Subsequently, the paper will present first and preliminary results including flight trials on C-160 Transall ANA/FRA (Autonome Navigationsanlage/Flugregelungsanlage) performed by the "Wehrtechnische Dienststelle 61". The possible application of this generic system varies from uninhabited reconnaissance / fighter aircraft over transport aircraft to rescue helicopters.
Author
Autonomous Navigation; Multisensor Fusion; Aircraft Guidance; Systems Integration; Pilotless Aircraft; Flight Management Systems; Air Navigation; Automatic Flight Control

19990007856 Universitaet der Bundeswehr Muenchen, Inst. fuer Systemdynamik und Flugmechanik, Neubiberg, Germany
LANDMARK NAVIGATION AND AUTONOMOUS LANDING APPROACH WITH OBSTACLE DETECTION FOR AIRCRAFT
Fuerst, Simon, Universitaet der Bundeswehr Muenchen, Germany; Werner, Stefan, Universitaet der Bundeswehr Muenchen, Germany; Dickmanns, Dirk, Universitaet der Bundeswehr Muenchen, Germany; Dickmanns, Ernst-Dieter, Universitaet der Bundeswehr Muenchen, Germany; Jul. 1998; 12p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A machine perception system for aircraft and helicopters using multiple sensor data for state estimation is presented. by combining conventional aircraft sensors like gyros, accelerometers, artificial horizon, aerodynamic measuring devices and GPS with vision data taken by conventional CCD-cameras mounted on a pan and tilt platform, the position of the craft can be determined as well as the relative position to runways and natural landmarks. The vision data of natural landmarks are used to improve position estimates during autonomous missions. A built-in landmark management module decides which landmark should be focused on by the vision system, depending on the distance to the landmark and the aspect conditions. More complex landmarks like runways are modeled with different levels of detail that are activated dependent on range. A supervisor process compares vision data and GPS data to detect mis-tracking of the vision system e.g. due to poor visibility and tries to reinitialize the vision system or to set focus on another landmark available. During landing approach

obstacles like trucks and airplanes can be detected on the runway. The system has been tested in real-time within a hardware-in-the-loop simulation. Simulated aircraft measurements corrupted by noise and other characteristic sensor errors have been fed into the machine perception system; the image processing module for relative state estimation was driven by computer generated imagery. Results from real-time simulation runs are given.
Author
Navigation Instruments; State Estimation; Autonomous Navigation; Landmarks; Onboard Data Processing; Multisensor Fusion; Aircraft Landing; Instrument Landing Systems; Computer Vision; Obstacle Avoidance; Flight Simulation

19990014364 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
LOW COST INERTIAL SYSTEMS
Cunningham, T., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 62-63; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

The advent of the Global Positioning System (GPS) has changed the rules for inertial navigation to a significant degree. by the year 2020 the role of inertial sensors will be as aiding and backup to satellite navigation derived data. Traditional inertial instruments error budgets will, in many instances, be relaxed by at least two orders of magnitude in non-jamming environments. The commercial market, driven by requirements in the automative electronics area, is expected to provide both accelerometers and gyros at very low cost. Many promising concepts are emerging for low cost inertial components and systems, with accuracy sufficient for a broad spectrum of military applications. These include innovative approaches such as silicon-based Microelectromechanical Systems (MEMS) technology.
Author
Microelectromechanical Systems; Inertial Navigation; Gyroscopes; Military Technology

19990014365 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
HIGH INTEGRITY GLOBAL PRECISION POSITIONING
Schmidt, G., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 64-65; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

The accuracy of satellite-based global precision positioning systems is primarily a function of the errors in the space and control segment of the system and in user equipment receiver implementation. The integrity (or reliability) of the system is also dependent on the space and control segment, on the receiver user equipment implementation, and dependent on interference (intentional or otherwise) to the broadcast signals. by the year 2020, it is expected that sub-meter accuracies will be obtainable thus allowing navigation and guidance of vehicles with very high 3 dimensional accuracy, including the vertical dimension. In addition to the high level of position accuracy provided by satellite navigation, extremely high levels of velocity and time accuracy will be achieved through closely-coupled integration with inertial sensors. However, jamming and intentional interference are expected to remain a serious issue for military operations, as well as civilian use, in spite of great improvements in satellite navigation receiver antijamming capability.
Author
Jamming; Inertial Navigation; Accuracy; Military Operations; Positioning; Navigation Satellites

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

19950021083 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
COMPOSITE REPAIR OF MILITARY AIRCRAFT STRUCTURES
LA REPARATION COMPOSITE DES STRUCTURES D'AVIONS MILITAIRES
Jan 1, 1995; 290p; In English; In French; 79th, 3-5 Oct. 1994, Seville, Spain; See also 19950021084 through 19950021107
Report No.(s): AGARD-CP-550; AD-A293056; ISBN 92-836-0010-X; Copyright Waived; Avail: CASI; A13, Hardcopy; A03, Microfiche; Original contains color illustrations

The AGARD Structures and Materials Panel held a specialists' Meeting to address composite repair of military aircraft. The meeting focused on two main areas, repair of metal structures using composite patches and repair of composite structures using composite or metal patches. The work presented had direct application to the maintenance and support of military aircraft. Repair of military aircraft provides both a means to extend the useful life of the airframe beyond the original design life and a method to maintain military readiness by returning damaged aircraft to service.
Aircraft Maintenance; Aircraft Structures; Composite Structures; Conferences

19950021084 Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia
BONDED COMPOSITE REPAIR OF METALLIC AIRCRAFT COMPONENTS: OVERVIEW OF AUSTRALIAN ACTIVITIES
Baker, A. A., Defence Science and Technology Organisation, Australia; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 14 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

After first providing an overview of the status of Australian applications of bonded composite repairs to metallic aircraft structure (mainly based on boron/epoxy composites) the problems in certifying composite repairs to critical cracks in primary metallic structure are discussed. The development of acceptable generic certification procedures is essential if the use of this efficient cost-effective repair technology is to be widely employed in military and civil aircraft. One requirement for certification is the ability to predict the fatigue-crack growth behavior in patched components. An approach to developing this capability is described, based on Rose's model to estimate stress intensity in patched panels. The model is extended to allow for disbonding damage in the patch system. Experimental results are presented to demonstrate the validity of this approach for boron/epoxy-FM73 repairs to aluminum alloy 2024T3.
Author
Aircraft Maintenance; Aircraft Structures; Boron-Epoxy Composites; Certification; Composite Structures; Cracks; Structural Analysis

19950021085 Textron Specialty Materials, Lowell, MA, United States
STATUS OF BONDED BORON/EPOXY DOUBLERS FOR MILITARY AND COMMERCIAL AIRCRAFT STRUCTURES
Belason, E. B., Textron Specialty Materials, USA; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 12 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Bonded boron/epoxy doublers are an alternative method vs. riveted doublers for repair and reinforcement of metallic aircraft structures. The boron/epoxy doublers provide cost and/or performance advantages for many applications. Today over 4,500 are flying on military aircraft, mostly in Australia and the U.S.A., and the use is increasing. Commercial aircraft, which are also aging, are beginning to use this technology, with about 50 boron doublers flying for flight evaluation since 1989 (plus about another 100 since the mid 1970s in France). This paper summarizes the major uses of boron/epoxy doublers, focusing on recent and current U.S. applications (other papers at this Meeting describe activities in Australia, Canada, and France). These include a 1993 report summarizing the successful use on the wing pivot of over 400 F-111s for 20 years (no disbonds have been noted); fleetwide installations on the B-1 and C-141 (over 1800 doublers); and flight testing on F-16, T-38, C-130 and KC-135 aircraft. Commercially there have been successful flight evaluations on 2 Fed Ex 747s and the Lycoming ALF 502 engine cowl on 2 BAE 146s. A Service Bulletin has been issued for retrofit of over 1200 cowls for the latter. This paper also summarizes the installation process (which is very viable), and describes two recent technical advances in chemically preparing aluminum surfaces for bonding of boron/epoxy doublers. This paper also presents the results of an extensive test

program sponsored by Textron at Boeing of 110 ultimate tensile strength and 143 fatigue tests of boron/epoxy doublers bonded to 7075-T6 aluminum with simulated cracks.
Author
Aircraft Maintenance; Aircraft Structures; Bonding; Boron-Epoxy Composites; Flight Tests; Joints (Junctions); Pivots; Tensile Strength

19950021086 Defence Research Agency, Structural Materials Centre., Farnborough, Hampshire, United Kingdom
ADHESIVELY BONDED COMPOSITE PATCH REPAIR OF CRACKED ALUMINUM ALLOY STRUCTURES
Poole, P., Defence Research Agency, UK; Young, A., Defence Research Agency, UK; Ball, A. S., British Aerospace Defence Ltd., UK; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 12 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Research at the Defence Research Agency (DRA) on adhesively bonded composite patch repair of fatigue cracked aluminum alloy structures is reviewed briefly. Theoretical and experimental results are reported which indicate the effectiveness of such repairs in terms of the reductions in stress intensity factor due to patching. The influence of warm-moist environments on the long-term performance of bonded patches is considered, and the advantages and disadvantages of using carbon fiber reinforced plastic (CFRP) patches, rather than boron fiber reinforced plastic (BFRP) patches, are discussed. An investigation by British Aerospace of the feasibility of using bonded composite patches to repair cracked primary aircraft structures is summarized. For the range of applications investigated, bonded composite patch repairs are shown to offer potential savings of 60-75 percent, compared to conventional repair methods. The current position regarding in-service trials is summarized, with no evidence of crack growth after 990 flying hours.
Author
Adhesive Bonding; Aircraft Maintenance; Aircraft Structures; Boron Reinforced Materials; Carbon Fiber Reinforced Plastics; Crack Propagation; Exposure; Metal Fatigue

19950021087 Dassault Aviation, Saint-Cloud, France
COMPOSITE REPAIR OF METALLIC AIRFRAME: TWENTY YEARS OF EXPERIENCE ***REPARATIONS COMPOSITES DE STRUCTURES METALLIQUES: VINGT ANS D'EXPERIENCE***
Druet, Micheline, Dassault Aviation, France; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 8 p; In French; See also 19950021083; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

During the 70's, the availability of unidirectional boron fiber fabric at Dassault Aviation did allow reinforcement of metallic structures by direct ply lay up on the metal. to be able to apply these reinforcement on airplanes, it was necessary to define a resin system inducing low thermal stresses in the metal during its cure, and with acceptable mechanical properties after aging. Validation was done by simple tests on samples, by complex test with simultaneous thermal and mechanical cycling, and application of test repairs on the major fatigue test of the Mercure airplane. Reinforcements of that type are in service for almost 20 years on the Mercure airliner.
Author
Aircraft Maintenance; Airframes; Boron Fibers; Composite Structures; Fatigue Tests; Reinforcing Fibers; Resins; Thermal Cycling Tests; Thermal Stresses

19950021088 National Research Council of Canada, Structures, Materials and Propulsion Lab., Ottawa Ontario, Canada
BONDED COMPOSITE REPAIR OF THIN METALLIC MATERIALS: VARIABLE LOAD AMPLITUDE AND TEMPERATURE CYCLING EFFECTS
Raizenne, M. D., National Research Council of Canada, Canada; Benak, T. J., National Research Council of Canada, Canada; Heath, J. B. R., National Research Council of Canada, Canada; Simpson, D. L., National Research Council of Canada, Canada; Baker, A. A., Defence Science and Technology Organisation, Australia; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 12 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche; Original contains color illustrations

An investigation into the effectiveness of bonded boron/epoxy composite patch repairs on edge notched Al 2024-T3 sheets has been completed. Testing was carried out under variable amplitude load and temperature cycling. Nine sandwich type specimens were precracked of which eight were repaired using bonded precured unidirectional boron fiber reinforced epoxy patches. Three structural adhesive systems were evaluated, two thermally activated epoxies, FM73 and FM300, and a room temperature cure acrylic, Versilok 201. The variable amplitude load sequence used was FALSTAFF, a typical fighter aircraft loading spectrum. The temperature profile was derived from F/A-18 usage data. Temperatures varied between -35 C and +80 C with a one in eight temperature cycle occurrence of +108 C. The effect of moisture absorption in the adhesive and the matrix was also investigated. Bonded patches on three specimens were preconditioned to a moisture weight gain of 1.5 percent prior to testing. The data generated compares specimen fatigue crack growth rates between the three adhesives for three environments: room temperature, temperature cycled and temperature cycled with moisture preconditioning.
Author
Aircraft Maintenance; Boron Reinforced Materials; Boron-Epoxy Composites; Moisture; Temperature Effects; Thermal Cycling Tests; Variable Amplitude Loading

19950021089 Bombardier, Inc., Defence Systems Div., Montreal Quebec, Canada
DESIGN AND STRUCTURAL VALIDATION OF CF116 UPPER WING SKIN BORON DOUBLER
Smith, J., Bombardier, Canada; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 11 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Cracks were found around fastener holes in the critical area known as the 'Golden Triangle' on the upper wing skin of several CF116 aircraft. to restore the structural integrity of the wing, cracks around these fastener holes are removed and interference fit steel bushings are installed. A boron-epoxy doubler is then bonded over the reworked area to reduce stress levels. The doubler is viewed as a fatigue enhancement device and not as a repair to a cracked skin. An analytical methodology is used to assess the bond line integrity and the load transfer in the doubler. A 49% reduction of stress level is predicted by the bonded joint analytical approach. A finite element analysis reveals that a 47% stress reduction is expected in the exterior surface of the wing skin, while a 37% reduction in the interior surface is predicted. Based on a strain survey performed following the installation of a doubler on the CF116 full scale fatigue test, it is shown that analytical predictions agree with experimental results.
Author
Aircraft Maintenance; Aircraft Structures; Bonded Joints; Boron-Epoxy Composites; Cracks; Interference Fit; Stress Analysis; Structural Analysis; Structural Failure; Wings

19950021090 Georgia Inst. of Tech., Computational Modeling Center., Atlanta, GA, United States
A FEAM BASED METHODOLOGY FOR ANALYZING COMPOSITE PATCH REPAIRS OF METALLIC STRUCTURES
Pipkins, D. S., Georgia Inst. of Tech., USA; Atluri, S. N., Georgia Inst. of Tech., USA; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 16 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

A Finite Element Alternating Method based methodology applicable to the analysis of composite patch repairs of metallic structures is presented. The method is completely general and may be used to efficiently analyze factors affecting repair design such as: global stiffening of the aircraft structure due to the high stiffness of the composite patch; the effect of size, shape, thickness and material properties of the composite patch on the crack-tip stress intensity factors; the effect of the material properties of the adhesive on the crack-tip stress intensity factors; the effect of thermal cycling on the composite repair; and the effect of disbonds on the effectiveness of the composite repair.
Author
Aircraft Maintenance; Aircraft Structures; Composite Materials; Composite Structures; Finite Element Method

19950021091 Lockheed Aeronautical Systems Co., Marietta, GA, United States
STRUCTURAL MODIFICATION AND REPAIR OF C-130 WING STRUCTURE USING BONDED COMPOSITES
Grosko, J., Lockheed Aeronautical Systems Co., USA; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 9 p; In

English; See also 19950021083; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Lockheed Aeronautical Systems Company (LASC) -- in a program sponsored by the USA Air Force, Warner Robins Air Logistics Center, C-130 Directorate -- has developed concepts wherein bonded high-modulus composite materials can be applied to structurally repair or enhance the wing box of C-130 aircraft. Two separate approaches are taken. In the first, boron/epoxy reinforcing strips are applied to wing box lower surface structure to relieve high stress at a particular location in the wing surface panel. This modification is ideally used on undamaged structure to prevent wing surface cracking. In the second approach, graphite reinforced patches are applied in the same vicinity to arrest crack growth. Both concepts were successfully demonstrated on opposite sides of a full-scale wing test article. Design details, the materials and processes, the methods of installation and the measured effectiveness of both the boron/epoxy strips and the graphite/epoxy patches are discussed.
Author (revised)
Aircraft Maintenance; Aircraft Structures; Boron-Epoxy Composites; Composite Structures; Full Scale Tests; Graphite-Epoxy Composites; Wing Panels

19950021092 Lehigh Univ., Inst. of Fracture and Solid Mechanics., Bethlehem, PA, United States
EVALUATION OF PATCH EFFECTIVENESS IN REPAIRING AIRCRAFT COMPONENTS
Sih, G. C., Lehigh Univ., USA; Gdoutos, E. E., Thrace Univ., Greece; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 8 p; In English; See also 19950021083; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Reinforcement of aircraft components by patching is never completely effective because of improper bonding or damage of the reinforcement in service. There is always the uncertainty for evaluating the remaining strength or life of a repaired structure. Developed in this work is a methodology for evaluating the reinforcement effectiveness by considering two basic types of partially damaged patches; they are referred to as collinear and transverse debonding with respect to the crack plane. The former refers to debonding over a region ahead of only one of the crack tips where the load and geometry are symmetric across the crack plane, while the latter is concerned with debonding over a region to the side of the crack where symmetry is no longer preserved across the crack plane. Finite elements are employed to obtain the stresses and strains from which the strain energy densities can be determined for analyzing the failure behavior of the patched panels. The local and global maximum of the minimum strain energy density function, designated by((dW/dV)(sup max, sub min))(sub L) at L and ((dW/DV)(sup max, sub min)(sub G) at G, are found and applied to define failure instability. The distance ell between L and G serves as a measure of crack instability; it increases with the debonded area. That is, debonding tends to enhance failure instability by fracture initiating from the existing crack. For approximately the same area of debonding, crack initiation for collinear debonding would be more unstable as compared with transverse debonding for loads directed normal to the crack. Introduced also is a Patch Effectiveness Index (PEI) that serves as a measure of the load carrying capacity of the damaged patch. In this case, transverse debonding is more detrimental than collinear debonding because a more significant reduction in the load transfer path occurs in the former case. In general, both ell and PEI would have to be considered for assessing the integrity of the damaged patch.
Author
Aircraft Maintenance; Aircraft Structures; Bonding; Cracking (Fracturing); Cracks; Debonding (Materials); Strain Energy Methods; Stress Analysis

19950021093 Naval Air Warfare Center, Aircraft Div., Warminster, PA, United States
FIELD REPAIR MATERIALS FOR NAVAL AIRCRAFT
Cochran, R., Naval Air Warfare Center, USA; Trabocco, R., Naval Air Warfare Center, USA; Mehrkam, P., Naval Air Warfare Center, USA; Diberardino, M., Naval Air Warfare Center, USA; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 7 p; In English; See also 19950021083; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Navy is unique in that a portion of the maintenance actions performed on operational aircraft must be accomplished on board ship or in remote field locations. Historically, Navy driven composite repair programs have addressed materials and concepts specifically directed at accomplishing repairs in the fleet operating environment. This paper discusses recent developments in the area of composite repair materials for the application of bonded patches to honeycomb and complex shaped monolithic composite structure. A two part adhesive that meets the storage and processing requirements for field repair applications was evaluated for use in repair of honeycomb structure. Low temperature adhesive processing and honeycomb compatibility tests were investigated. In another effort, wet lay-up repair resins and processes were characterized for repair of highly curved composite structure. The materials and equipment used in the study are fully compatible with field repair requirements. Composite repair materials for application of bonded patches to honeycomb and complex shaped monolithic composite structure are described. Low temperature adhesive processing development for bonding composite patches to moisturized structure is described. Cure temperatures as low as 90 C were used for curing a two part ambient storable adhesive. Mechanical properties and thermal stability of the cured adhesive is reported using a number of cycles. In another effort wet lay-up repair resins and processes were characterized which allow for the fabrication of fully inspectable wet lay-up patches. The materials and equipment are fully compatible with field repair requirements. Laminate mechanical properties and resin storage stability were characterized and reported.
Author
Adhesive Bonding; Adhesives; Aircraft Maintenance; Composite Structures; Honeycomb Structures; Lay-Up; Resins; Thermal Stability

19950021094 Deutsche Aerospace A.G., Military Aircraft Div., Munich, Germany
ON AIRCRAFT REPAIR VERIFICATION OF A FIGHTER A/C INTEGRALLY STIFFENED FUSELAGE SKIN
Bauer, J., Deutsche Aerospace A.G., Germany; Maier, A., Deutsche Aerospace A.G., Germany; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 14 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

A considerably large four point bending test box was available simulating the curved integrally stiffened CFC fuselage skin of a fighter aircraft. This box was used for a skin repair trial with subsequent testing. The repair was performed in the environment of an external test laboratory, i.e. abroad of the original shop or maintenance facilities. 'On Aircraft' conditions have been simulated with all the referring access, tooling and quality assurance difficulties. The repaired test box demonstrated during static testing, loading the repair in tension, compression and shear, that the applied repair procedure is feasible to be applied on CFC structures. The repair procedure and the subsequent testing will be presented and the results will be discussed.
Author
Aircraft Maintenance; Bend Tests; Fiber Composites; Fuselages; Load Tests; Skin (Structural Member); Static Tests; Tensile Tests

19950021095 Lockheed-Fort Worth Co., Fort Worth, TX, United States
RAPID REPAIR OF LARGE AREA DAMAGE TO CONTOURED AIRCRAFT STRUCTURES
Frailey, James A., Lockheed-Fort Worth Co., USA; Carter, Douglas W., Wright Lab., USA; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 9 p; In English; See also 19950021083; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

In a program sponsored by Air Force Wright Laboratory (WL/FIVST), Lockheed Fort Worth Company has developed field-level procedures for repair of large area damage to highly contoured aircraft structures. The combination of aircraft structures designed with enhanced survivability and the utilization of larger and more powerful ballistic threats have resulted in the requirement to develop new, creative approaches for rapid repair of large area structural damage. Furthermore, current aircraft design employing advanced composite materials on highly contoured surfaces increases the challenge of implementing workable battle damage repairs. This paper details the development of an advanced battle damage repair concept designed to repair damage up to approximately 15 inches in diameter on highly contoured surfaces. It employs a quick, reusable tooling mold that replicates the contour of the damaged aircraft for the purpose of processing a composite patch. Several one year room temperature stor-

able, thermoset, composite systems were examined for processability, handleability and mechanical performance to determine their suitability as repair patch materials. The most promising were further tested and demonstrated in a large scale validation test.
Author
Aircraft Design; Aircraft Maintenance; Aircraft Structures; Composite Materials; Composite Structures; Curved Panels

19950021096 Deutsche Aerospace A.G., Military Aircraft Div., Munich, Germany
COMPOSITE REPAIR OF A CF18: VERTICAL STABILIZER LEADING EDGE
Maier, A. E., Deutsche Aerospace A.G., Germany; Guenther, G., Deutsche Aerospace A.G., Germany; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 16 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes the engineering and manufacturing procedures that were applied in a repair task of a CF18 Vertical Stabilizer Leading Edge, made out of CFC honeycomb structure with multiple in-service impact damages in an aerodynamic sensitive area of the fin. 'On-aircraft' damage assessment, manufacturing of a relatively thin contoured CFC doubler, replacement of metal honeycomb core and finally quality assurance and strength verification procedures of the repair are described to restore full design strength of the component and the operational aircraft capability.
Author
Aircraft Maintenance; Composite Structures; F-18 Aircraft; Fiber Composites; Honeycomb Structures; Leading Edges; Stabilizers (Fluid Dynamics)

19950021097 Defence Research Establishment Pacific, Victoria British Columbia, Canada
COMPOSITE REPAIR ISSUES ON THE CF-18 AIRCRAFT
Russell, A. J., Defence Research Establishment Pacific, Canada; Ferguson, J. S., Defence Research Establishment Pacific, Canada; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 8 p; In English; See also 19950021083; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper addresses three separate composite repair issues currently being investigated at the Defence Research Establishment Pacific (DREP) in support of Canada's CF-18 aircraft. First, the problem of skin/core debonding that can occur during elevated temperature bonded repairs of honeycomb sandwich structure is discussed and the results of tests which help to quantify the role played by bondline degradation are presented. Next, the final development phase of an on-going effort to establish a reliable and effective means of repairing delamination damage is reported. In particular, the design of a resin injection device and a series of tests to evaluate its performance are described. Finally, a battle damage repair issue, namely the advantages and disadvantages of cleaning up the damaged composite material found around entry and exit holes created by live fire, is discussed. Test data is presented which compares the different consequences under tensile and compression loading.
Author
Aircraft Maintenance; Bonded Joints; Composite Structures; Compression Loads; Debonding (Materials); Delaminating; Honeycomb Structures; Sandwich Structures; Tensile Stress

19950021098 Northrop Grumman Corp., Aircraft Div., Hawthorne, CA, United States
REPAIR TECHNOLOGY FOR THERMOPLASTIC AIRCRAFT STRUCTURES
Heimerdinger, M. W., Northrop Grumman Corp., USA; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 12 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Flight Dynamics and Materials Directorates of the U.S. Air Force Wright Aeronautical Laboratories jointly sponsored a program for 'Repair Technology for Thermoplastic Aircraft Structures' (REPTAS) performed by Northrop Corporation, Aircraft Division. In the program Northrop developed, validated and demonstrated on-aircraft repair design concepts and processes for field repair of advanced thermoplastic structures. The REPTAS program was accomplished through the performance of a 48-month effort comprising three phases. Phase 1 assessed field level repair facilities and technology that are currently available and identified their applicability to repair thermoplastic (TP) structures. A baseline aircraft structure was selected to validate the selected repair process. Currently available thermoplastic materials were reviewed and materials selected for evaluation. In the selection process the objective was to select one semicrystalline, one amorphous, and one pseudo-thermoplastic material. APC-2 was evaluated as the baseline material for the process development efforts. Novel processing techniques were investigated for the repair procedures. Phase 2 developed the selected technologies for the on-aircraft repair of TP structures at a coupon and subelement level. Design concepts were developed that are compatible with field level capabilities and restore structural integrity to the aircraft. In the process of developing a bonding procedure using polyetheretherketone (PEEK) as the bonding film, it became apparent that the required bonding temperature of 385 C (725 F) created internal thermal stresses in the base structure and resulted in unacceptable delaminations. As an alternative, an investigation of amorphous bonding was included which demonstrated its feasibility for TP repair. In Phase 3 a full-scale advanced thermoplastic composite structural component was selected and used as a demonstration article for the selected design concept.
Derived from text
Aircraft Maintenance; Aircraft Structures; Amorphous Materials; Bonding; Composite Structures; Delaminating; Stress Analysis; Structural Failure; Thermoplasticity

19950021099 Vought Corp., Aircraft Div., Dallas, TX, United States
REPAIR OF HIGH TEMPERATURE COMPOSITE AIRCRAFT STRUCTURE
Connolly, Jerome J., Vought Corp., USA; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 12 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes the final portion of a high temperature composite repair development program sponsored by Wright Patterson Materials Directorate. Initially, BMI adhesives and prepregs were selected based on their compatibility with in-service repair cure scenarios. These typically involve curing in a non-autoclave environment using vacuum consolidation only. The selected material systems were then used to develop a comprehensive repair procedure for highly curved aircraft structure. Once developed, the procedure was then applied to a curved structure representative of a flight surface leading edge. Baseline and repair specimens were fabricated and tested in compression at both room temperature dry and elevated temperature dry conditions. The results of these test validated the repair procedure.
Author
Adhesives; Aircraft Maintenance; Aircraft Structures; Composite Materials; Composite Structures; Temperature Effects

19950021100 British Aerospace Defence Ltd., Military Aircraft Div., Preston, United Kingdom
COMPOSITE REPAIR OF COMPOSITE STRUCTURES
Frame, C. S., British Aerospace Defence Ltd., UK; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 11 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Composite repair results from previous Phases of the Ministry of Defence/British Aerospace funded 'Defect, Damage and Repair' (DDR) program are used to illustrate the ability to perform adequate strength repairs to composite structures using composite materials. Problems inhibiting the wider use of composite repairs are discussed and work in progress in the current Phase of the DDR program aimed at overcoming these problems, is presented.
Author
Aircraft Maintenance; Composite Materials; Composite Structures

19950021101 Eurocopter Deutschland G.m.b.H., Munich, Germany
EXTERNAL PATCH REPAIR OF CFRP/HONEYCOMB SANDWICH
Wolf, K., Eurocopter Deutschland G.m.b.H., Germany; Schindler, R., Eurocopter Deutschland G.m.b.H., Germany; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 11 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper addresses the repair of impact-damaged honeycomb sandwich structures with thin skins made of carbon fiber reinforced

plastic (CFRP). An experimental study concerned with evaluating several types of bonded external patch repairs is presented. The evaluation included cocured as well as precured patch techniques utilizing advanced repair materials. Three repair schemes were applied to honeycomb sandwich manufactured from 125 C as well as 175 C curing carbon fiber reinforced fabric prepregs. The effectiveness of the repairs was examined through a series of static and fatigue compression tests. Based on the mechanical test results and a comparison of the repair procedures it was found that the bonded precured patch concept is the most suitable approach for repairing impact-damaged sandwich structures under field-level maintenance limitations.
Author
Aircraft Maintenance; Aircraft Structures; Carbon Fiber Reinforced Plastics; Compression Tests; Curing; Fatigue Tests; Honeycomb Structures; Sandwich Structures; Static Tests

19950021102 Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia
SCARF REPAIRS TO GRAPHITE/EPOXY COMPONENTS
Baker, A. A., Defence Science and Technology Organisation, Australia; Chester, R. J., Defence Science and Technology Organisation, Australia; Hugo, G. R., Defence Science and Technology Organisation, Australia; Radtke, T. C., Defence Science and Technology Organisation, Australia; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 12 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Significant damage to graphite/epoxy laminates up to 16 plies in thickness is often repaired with a bonded external patch. This type of repair is well suited to honeycomb panels and is relatively easy to apply even under field conditions. Thicker laminates generally carry too much load for external patch repairs and so either bolted patches or scarf repairs are generally used. Scarf repairs exhibit a nominally uniform shear stress distribution within the joint and have the advantage of low peel stress due to the lack of eccentricity in the load path. Scarf repairs are, however, difficult to produce, may involve the removal of a significant amount of parent material, and the uniform shear stresses may make the joint susceptible to creep failure. An experimental program was undertaken to determine the strain capacity of a scarf repair to a 21 ply laminate. The aim of the program is to demonstrate a strain capability in the repair of at least 5200 microstrain when tested under hot/wet conditions. Although some of the specimens tested have achieved this strain level, the performance of the current scarf joint is marginal under these conditions. Detailed analysis of this joint shows that high stresses arise from ply drop-offs within the repair doubler and at the ends of the scarf taper. Good correlation has been observed between the results from the Finite-Element models and those from experimental specimens, indicating that the models are a useful tool to assist in the design of joints of this type.
Author
Creep Properties; Damage; Finite Element Method; Graphite-Epoxy Composites; Honeycomb Structures; Laminates; Stress Analysis; Thickness

19950021103 Turkish Land Forces Command, Ankara, Turkey
SCARF JOINT TECHNIQUE WITH COCURED AND PRECURED PATCHES FOR COMPOSITE REPAIR
Elaldi, F., Turkish Land Forces Command, Turkey; Lee, S., Institute for Aerospace Research, Canada; Scott, R. F., Institute for Aerospace Research, Canada; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 12 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The scarf joint technique is one of the latest techniques used for repairing composite aircraft structures. This paper describes scarf joints comprised of vacuum and autoclave precured and cocured fiber glass epoxy patches bonded to autoclave and vacuum precured parent fiber glass epoxy laminates. Autoclave and vacuum cured parent laminates and the scarf joints were prepared and exposed to the same temperature and moisture environment for comparison. All specimens were loaded in tension at three temperatures. Interlaminar shear strength (ILSS) tests were also carried out for the parent materials. As expected, the tensile strength and ILSS decrease when the material has been exposed to moisture and tested at elevated temperature. No significant difference was reported for either tensile strength or ILSS between autoclave and vacuum cured materials. The room temperature repair efficiencies are reported for single scarf repairs comprised of vacuum cocured and precured patches. These repair efficiencies were found to be similar to the efficiency of the autoclave precured patch repair. This result supports the feasibility of scarf joint repairs in base level facilities.
Author
Aircraft Maintenance; Aircraft Structures; Composite Structures; Epoxy Resins; Fiber Composites; Glass Fibers; Laminates; Prepregs; Shear Strength; Temperature Effects

19950021104 Aerospatiale, Composite Structures Div., Toulouse, France
COMPOSITE OR METALLIC BOLTED REPAIRS ON SELF-STIFFENED CARBON WING PANEL OF THE COMMUTER ATR72 DESIGN CRITERIA, ANALYSIS, VERIFICATION BY TEST
Tropis, A., Aerospatiale, France; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 21 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The introduction into service, in 1989, of ATR72 with an outer wing in carbon led Aerospatiale to develop primary structure repair processes which fulfill Airworthiness requirements and which could be performed by the airlines in typical maintenance conditions. This paper describes the two types of bolted repairs developed within the scope of the wing certification: composite doubler or metallic doubler. An analytical microcomputer calculation program allows the critical area and the strength capability of the repaired panel to be determined. This program is validated by tests.
Author
Aircraft Maintenance; Aircraft Reliability; Carbon Fibers; Fiber Composites; Wing Panels

19950021105 Deutsche Airbus G.m.b.H., Hamburg, Germany
DAMAGE OCCURRENCE ON COMPOSITES DURING TESTING AND FLEET SERVICE: REPAIR OF AIRBUS AIRCRAFT
Stemmer, G., Deutsche Airbus G.m.b.H., Germany; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 8 p; In English; See also 19950021083; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The application of composite materials to civil aircraft structure was growing during the past 25 years with every new aircraft which went into service. With these materials in commercial use it became necessary to define repairs in the case the component becomes damaged. During fatigue testing at component level the limits for allowable damage and maximum repair sizes were determined for standard damage events and manufacturing defects. The values are depending on structural design, material behavior and local strains or stresses. For simple damages on regular structures necessary repair actions are defined in the Structural Repair Manual. With an approved inspection philosophy the structure is under observation during airline service. It will be presented how the repair philosophy within Airbus Industrie partner companies is defined and which damages were reported on aircraft already in service. Some examples should explain the lessons we have learned from those failures occurred during component testing and airline service.
Author
Aircraft Maintenance; Aircraft Structures; Composite Materials; Composite Structures; Damage; Fatigue Tests; Stress Analysis; Structural Design

19950021106 Construcciones Aeronauticas S.A., Madrid, Spain
REPAIRS OF CFC PRIMARY STRUCTURES
Garcianunez, H., Construcciones Aeronauticas S.A., Spain; Barriocardaba, A., Construcciones Aeronauticas S.A., Spain; Franganillo, A., Construcciones Aeronauticas S.A., Spain; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 10 p; In English; See also 19950021083; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The use of composites in the last decades has been mainly restricted to secondary structures, with repair methods well known to the airlines. In today's aircraft, a significant amount of primary structure is designed and built in high strength composite materials. Repairs for these elements must take into consideration the restoration of structural strength and stiffness, still being easy to be applied by aircraft operators, with a minimum of special facilities, and requiring a minimum of aircraft-on-ground time. A large number of important structural elements in CFC now in service have been designed and

manufactured by CASA. This paper describes how composite repairs are dealt with at CASA, starting from the design board, and the analyses and tests carried out to demonstrate compliance with certification requirements.
Author
Aircraft Maintenance; Aircraft Structures; Composite Structures; Fiber Composites; High Strength

19950021107 Royal Australian Air Force, Aero-mechanical Technologies and Standards., Amberley, Australia
THE DEVELOPMENT OF AN ENGINEERING STANDARD FOR COMPOSITE REPAIRS
Davis, M. J., Royal Australian Air Force, Australia; AGARD, Composite Repair of Military Aircraft Structures; Jan 1, 1995, 11 p; In English; See also 19950021083; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The RAAF has used bonded composite patches for structural repairs to aircraft for nearly twenty years, and they are now seen as a reliable alternative to mechanically fastened repairs. to control the implementation of the repair technology, RAAF propose to adopt Engineering Standard C5033 on Composite Materials and Adhesive Bonded Repairs. The Standard addresses repair authorization and design, as well as repair methodology and quality control. This paper will describe the philosophy of repair design contained in the standard, and outline the materials and process controls necessary for performance of repairs which comply with ISO 9001.
Author
Adhesive Bonding; Aircraft Maintenance; Aircraft Structures; Bonded Joints; Composite Materials; Composite Structures; Quality Control; Standardization

19950023082 Advisory Group for Aerospace Research and Development, Flight Mechanics Panel, Neuilly-Sur-Seine, France
RELIABILITY AND MAINTAINABILITY *FIABILITE ET MAINTENABILITE*
Howell, Jan M., Test Wing, 0412th, Edwards AFB, USA; Feb 1, 1995; 63p; In English
Report No.(s): AGARD-AG-300-VOL-13; ISBN 92-836-1014-8; Copyright Waived; Avail: CASI; A04, Hardcopy; A01, Microfiche

This AGARDograph outlines the rudiments of reliability and maintainability (R&M) evaluations conducted during initial flight test programs. Many organizations, both military and civilian, prefer to defer R&M evaluations until the new equipment has been delivered to the eventual user. The U.S. Air Force Flight Test Center has long conducted R&M evaluations during initial flight test and has found value in that process. This document discusses, first, the objectives of the early evaluations. Then, the acquisition process and the test planning process, as they relate to R&M evaluations, are presented. The test planning section discusses the data needed for a successful R&M evaluation and the sources of such data. The conduct of the test, analysis of results, and subsequent reporting methods are delineated. Follow-up actions that are needed after the test are considered. In conclusion, the document lists some R&M considerations for the future.
Author
Aircraft Maintenance; Aircraft Reliability; Flight Tests; Performance Prediction; Quality Control

19950023202 Princess Alexandra Hospital, Swindon, United Kingdom
A GENERIC SPECIFICATION FOR SPECIAL PURPOSE AEROMEDICAL EQUIPMENT
Spencer, I., Princess Alexandra Hospital, UK; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 5 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

A generic specification for Special Purpose Aeromedical Equipment (SPAME) has been prepared which, if met, would largely overcome the problems faced by medical operators seeking clearance for the use of such equipment in aircraft. It is suggested that this specification might be used by NATO medical forces as a base for future standardization and thus perhaps increased interoperability of aeromedical resources and equipment.
Author
Aerospace Medicine; Air Transportation; Equipment Specifications; Evacuating (Transportation); Medical Equipment

19950024644 Hoh Aeronautics, Inc., Lomita, CA, United States
UNIFIED CRITERIA FOR ACT AIRCRAFT LONGITUDINAL DYNAMICS
Hoh, Roger H., Hoh Aeronautics, Inc., USA; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 9 p; In English; See also 19950024640; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper reports research done by USAF to adequately predict the susceptibility to pilot induced oscillation (PIO) and AGARD's response to the research. It discusses different criteria and characteristics that help to analyze PIO: the concept of phase delay, triggers, the effects of rate limiting, response characteristics and appropriate analysis techniques, and feel system influence. From the evidence presented by USAF, AGARD concludes that there is sufficient evidence that a PIO could be predicted, as could the effects of the bobweight. However, the impact of the actuation behavior may have had a dominant effect on the overall behavior of the aircraft.
CASI
Aerodynamic Characteristics; Aircraft Control; Aircraft Stability; Longitudinal Stability; Pilot Induced Oscillation

19950025582 Wright Lab., Flight Dynamics Directorate., Wright-Patterson AFB, OH, United States
FLIGHT EVALUATION OF FOREBODY VORTEX CONTROL IN POST-STALL FLIGHT
Walchli, Lawrence A., Wright Lab., USA; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 10 P; In English; See also 19950025568; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Loss of directional stability in a post-stall flight environment has become a major design issue for future fighter aircraft. Numerous studies have addressed this issue, either from an aerodynamics perspective or through use of propulsive forces generated by vectoring exhaust nozzles. The X-29 aircraft, with its forward swept wing and other advanced technologies, suffers loss of directional power above 40 degrees angle of attack (AOA). An exploratory development program was undertaken on this configuration to regain the lost stability through use of a pneumatic system on the aircraft nose which influenced the external flow field, generating significant side forces useful for control. Wind tunnel test results were inserted into the X-29 flight simulator at NASA Dryden Flight Research Facility and the simulator was used to support a critical flight experiment of this technology. This experiment is the subject of this paper.
Author
Directional Stability; Flight Tests; Forebodies; Noses (Forebodies); Swept Forward Wings; Vortices; X-29 Aircraft

19950025586 Air Force Flight Test Center, Edwards AFB, CA, United States
FLIGHT TEST RESULTS OF THE F-16 AIRCRAFT MODIFIED WITH AXISYMMETRIC VECTORING EXHAUST NOZZLE
Kidman, D., Air Force Flight Test Center, USA; Vanhoy, D., Air Force Flight Test Center, USA; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 19 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents results from flight testing an F-16 aircraft modified with the Axisymmetric Vectoring Exhaust Nozzle (AVEN). This includes an assessment of the AVEN nozzle and the modified F-16 flight control system to provide stability and control power in an expanded maneuvering envelope, an assessment of flying qualities, and an overall assessment of tactical utility. Also included are lessons learned regarding the testing and implementations of active control technology.
Author
Active Control; Control Systems Design; Exhaust Nozzles; F-16 Aircraft; Flight Control; Flight Tests

19950025587 Dassault Aviation, Saint-Cloud, France
CATAPULT-LAUNCHING OF THE RAFALE DESIGN AND EXPERIMENTATION *CATAPULTAGE DU RAFALE CONCEPTION ET EXPERIMENTATION*
Fleygnac, D., Dassault Aviation, France; Lequeux, L., Dassault Aviation, France; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 12 p; In French; See also

19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The RAFALE program was conceived from the beginning to define, develop and produce a general-purpose aircraft meeting the future needs of the State - the Army, Air Force, and Navy. The Navy version is intended to equip the French naval air forces by the end of the decade. It will operate starting from the conventional propulsion Foch and the Charles De Gaulle nuclear aircraft carrier. Furnished with a numerical flight control system, the RAFALE M01 prototype is the first aircraft with delta canards to be catapulted from an aircraft carrier (April 1993). It is also the first naval aircraft to use the original method of catapult-assisted dihedral launching. The study of naval aircraft catapult launching combines the technical disciplines implicit in the design of fighter aircraft: aerodynamics, structure, flight control, and aircraft systems. In the framework of this conference, the discussion has particularly focused on flight dynamics. It covers: the specifications of the RAFALE naval launching; some related aspects at the aircraft catapult design: flight control system, improved performance systems (dihedral launch, high-energy recovery rate); the ground tests; and the tests at sea.
Transl. by CASI
Aircraft Design; Canard Configurations; Catapults; Flight Control; Military Aircraft; Numerical Control; Propulsion; Prototypes

19950025592 Deutsche Aerospace A.G., Military Aircraft Div., Munich, Germany
X-31: A PROGRAM OVERVIEW AND FLIGHT TEST STATUS
Ross, H., Deutsche Aerospace A.G., Germany; Neuberger, U., Deutsche Aerospace A.G., Germany; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 7 p; In English; See also 19950025568; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The objective of the X-31 program (the first international US/German experimental program) was to develop a new fighter that can execute tactical maneuvers up to an angle of attack (AOA) of 70 degrees (which is far beyond the stall AOA) without the pilot losing control of the aircraft (poststall capability, PST). This capability extends aircraft performance with respect to deceleration capability, turn rate and radius, and pointing capability for weapon firing considerably and results in a distinctive improvement of the tactical advantages in close-in combat. The prerequisite for these capabilities is the use of thrust vector control to boost or even replace the aerodynamic controls which lose their effectiveness at low speeds and in the poststall regime. The technical development of the PST capability requires the application of new technologies in the areas of aerodynamics (separated vortex flow), propulsion (inlet aerodynamics and jet deflection) and in particular, flight control (unstable configurations, digital flight control systems, integrated thrust vector control). Flight test results of the X-31 showed that the four important basic maneuvers (safe flight and maneuvering at 70 deg. AOA, 360 deg. rolls about the velocity at 70 deg. AOA, poststall maneuvers at high load factors, and the 180 deg. J (or Herbst) turn with extremely small turn radii and high turn rates) have been successfully demonstrated. In Nov./Dec. 1993 the flight envelope was extended into the supersonic and flights with a helmet mounted display (HMD) were conducted. This paper gives an overview of the X-31 program and the results of the test flights.
CASI
Aerodynamic Stalling; Aircraft Control; Angle of Attack; Flight Tests; Maneuverability; Thrust Vector Control; X-31 Aircraft

19950026724 Aerodata Flugmesstechnik G.m.b.H., Brunswick, Germany
INTEGRATED SPECIAL MISSION FLIGHT MANAGEMENT FOR A FLIGHT INSPECTION AIRCRAFT
Redeker, A., Aerodata Flugmesstechnik G.m.b.H., Germany; Haverland, M., Aerodata Flugmesstechnik G.m.b.H., Germany; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 3 p; In English; See also 19950026705; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

Flight Inspection of military and civil radionavigation aids requires calibration aircraft with a complex mission equipment. The measurement patterns and their flight procedures differ from usual flight procedures, which cannot be performed with normal flight management/autopilot systems. On the other hand there is a requirement for an automatic guidance, in order to increase the reproducibility of calibration results and to assist the crew operating in areas with high traffic density. Special mission flight management systems, which are available on the market, are not an elegant solution for flight inspection applications. The flight inspection system (FIS) contains already all elements of a flight management system (FMS), and the FIS has more comprehensive information on navigational data. The system approach of an integrated FIS/FMS system is presented, where special mission profiles are generated and interfaced to the autopilot. Flight test results and operational experience are reported.
Derived from text
Aircraft Instruments; Automatic Pilots; Flight Management Systems; Flight Tests; Inspection; Systems Integration

19960003574 Naval Postgraduate School, Navy-nasa Joint Inst. of Aeronautics., Monterey, CA, United States
PRESENT CAPABILITIES OF PREDICTING TWO-DIMENSIONAL DYNAMIC STALL
Ekaterinaris, J. A., Naval Postgraduate School, USA; Srinivasan, G. R., Sterling Software, Inc., USA; Mccroskey, W. J., Army Aviation Systems Command, USA; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 23 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The current status of computational methods in predicting dynamic stall is summarized. Computed results for unsteady, attached and separated, turbulent flows over airfoils undergoing oscillatory motion are presented. The compressible form of the Reynolds-averaged Navier-Stokes equations is used. Numerical integration of the governing equations is performed with an approximately factorized algorithm. The inviscid fluxes are evaluated using both central differences and an upwind-biased method. The ability of several turbulence models, widely used for the prediction of steady flows, is tested for the unsteady flows. Solutions computed with algebraic, one-equation, and two-equation turbulence models are compared with experimental data. For the fully turbulent flows with tripped boundary layer most turbulence models predict lift hysteresis reasonably well. Some turbulence models give good qualitative agreement with the measured drag and pitching moment hysteresis loops. The computed results for untripped flows, where a small transitional region at the leading edge exist, show that the key to the accurate prediction of the unsteady loads at stall conditions is the modeling of this transition region at the leading edge. A simplified criterion for the transition onset is used, and the transitional flow region is computed with a modified form of the turbulence model. The computed solutions, where the transitional flow region is included, show that the small laminar/transitional separation bubble formed during the pitch-up motion has a decisive effect on the near wall flow and the development of the unsteady loads. Finally, the numerical solutions show some sensitivity to the kind of numerical algorithm used despite the reasonably fine grids used.
Author
Aerodynamic Stalling; Airfoils; Computational Fluid Dynamics; Computational Grids; Helicopters; Inviscid Flow; Leading Edges; Navier-Stokes Equation; Numerical Integration; Rotor Aerodynamics; Separated Flow; Turbulence Models; Turbulent Flow; Two Dimensional Models; Unsteady Flow

19960003586 Sikorsky Aircraft, Stratford, CT, United States
FORWARD FLIGHT ROTOR AIRLOADS PREDICTIONS USING A COUPLED NAVIER-STOKES/FULL-POTENTIAL ANALYSIS
Berezin, C., Sikorsky Aircraft, USA; Sankar, L., Georgia Inst. of Tech., USA; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 10 p; In English; See also 19960003572; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Unsteady airloads predictions from a hybrid Navier-Stokes/full-potential code for a model UH-60A rotor in forward flight are presented. The code splits the physical domain into a near blade viscous region surrounded by an inviscid potential region. The two regions are coupled through boundary conditions on the interface surface separating them. In addition, the interface surface has been modified to dynamically adjust its position normal to the blade surface depending on the instantaneous distribution of vorticity in the viscous region. This allows roughly a 50 percent reduction of CPU time usage when compared with a standalone Navier-Stokes code. Comparison of the hybrid code surface pressures with the standalone Navier-Stokes results shows good agreement in quadrants one, two, and four. The

hybrid code overpredicts the extent of a separated region in the third quadrant which suggests further improvements to the unsteady interface boundary conditions are needed.
Author
Aerodynamic Loads; Aircraft Design; Boundary Conditions; Computational Fluid Dynamics; Computational Grids; Helicopters; Horizontal Flight; Navier-Stokes Equation; Potential Flow; Potential Theory; Rotor Aerodynamics; Unsteady Aerodynamics

19960003594 Defence Research Agency, Flight Dynamics and Simulation Dept., Bedford, United Kingdom
IN FLIGHT RESEARCH WITH INSTRUMENTED MAIN AND TAIL ROTOR BLADES USING THE DRA BEDFORD AEROMECHANICS RESEARCH LYNX HELICOPTER
Tarttelin, P. C., Defence Research Agency, UK; Martyn, A. W., Defence Research Agency, UK; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 12 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper serves to inform the reader about in-flight research at DRA Bedford on the DRA's Aeromechanics Lynx Control and Agility Testbed (ALYCAT) using instrumented main and tail rotor blades. The paper describes the instrumentation, data analysis techniques and flight test programs, with the initial results from recent trials using instrumented main rotor blades on ALYCAT presented for the first time, and results from the earlier trials using an instrumented tail rotor blade presented in more detail.
Author
Applications Programs (Computers); Blade-Vortex Interaction; Data Reduction; Flight Control; Flight Tests; Helicopters; Pressure Distribution; Pressure Sensors; Rotary Wings; Rotor Aerodynamics; Strain Gages

19960003596 Aix-Marseilles Univ., Inst. de Mechanique des Fluides.; **France**
DETERMINATION OF THE AERODYNAMIC LOADS OF THE ROTOR IN HOVERING, USING A LASER TECHNIQUE OF VELOCIMETRY *DETERMINATION DES CHARGES AERODYNAMIQUES DU ROTOR EN VOL STATIONNAIRE, A L'AIDE D'UNE TECHNIQUE DE VELOCIMETRIE LASER*
Berton, E., Aix-Marseilles Univ., France; Favier, D., Aix-Marseilles Univ., France; Maresca, C., Aix-Marseilles Univ., France; Nsimba, M., Aix-Marseilles Univ., France; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 6 p; In French; See also 19960003572
Contract(s)/Grant(s): DGA-90/169; DGA-92/061; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The study of the aerodynamic burden-sharing on a rotor of operative helicopter in hovering, is approached in this paper by means of a new technique of exploration by laser velocimetry, coupled to assessment of momentum and Kutta (KMA Method). The effectiveness of this method is evaluated for various parametric configurations of the hovering.
Author
Aerodynamic Loads; Helicopters; Hovering; Rotary Wings; Rotor Aerodynamics

19960003603 National Research Council of Canada, Applied Aerodynamics Lab., Ottawa Ontario, Canada
ANALYSIS OF ROTOR FORCES IN A SHIP AIRWAKE
Syms, G., National Research Council of Canada, Canada; Zan, S. J., National Research Council of Canada, Canada; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 12 p; In English; See also 19960003572; Sponsored in cooperation with the National Research Council of Canada
Contract(s)/Grant(s): DND-FE-220792-NRC-05; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche; Original contains color illustrations

This paper examines the helicopter/ship dynamic interface by combining both experimental and numerical analyses. The flow field over the flight deck of a frigate model was mapped experimentally in a wind tunnel using both stationary and flying hot-film sensors. Using the velocity time-histories measured in the wind tunnel, a numerical representation of the airwake which shares the same spectral characteristics was generated. A blade-element model fo the main rotor of a helicopter was then 'flown' in this numerical airwake to determine the steady and unsteady loads acting on the rotor. The results of a set of test simulations indicate: (1) that an increase in unsteady rotor loads occurs when spatial cross-correlation functions are included in the generation of the numerical flow field; (2) that the fluctuating vertical velocity has a greater effect on the unsteady rotor loads than the fluctuating horizontal velocity; and (3) that the spectra of unsteady forces and moments show similar broadband and resonant behavior at different free-stream velocities.
Author
Flow Distribution; Helicopters; Hovering; Interactional Aerodynamics; Loads (Forces); Numerical Analysis; Rotor Aerodynamics; Ships; Velocity Distribution; Wakes; Wind Tunnel Tests

19960003604 Southampton Univ., Dept. of Aeronautics and Astronautics.; **UK**
A THEORETICAL AND EXPERIMENTAL INVESTIGATION INTO THE ROTOR BLADE AEROELASTIC BEHAVIOUR OF A SHIPBORNE HELICOPTER DURING ROTOR ENGAGEMENT AND BRAKING
Newman, S. J., Southampton Univ., UK; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 10 p; In English; See also 19960003572; Sponsored by the DRA; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Under normal operating flight procedures, a helicopter main rotor revolves at a strictly controlled speed. The centrifugal forces generated keep balance with the aerodynamic loads with the result that the rotor blade motion, in particular the blade flapping, is maintained under control. to reach the normal rotational speeds the rotor must of course pass through lower speeds, both during acceleration and deceleration, and during these periods the blades can fall prey to the phenomenon of blade sailing. With this, not inconsiderable aerodynamic loads can be generated when the helicopter is operating in high winds and with the reduced centrifugal forces because of the lower rotor speeds, the blade flapping motion can build up to dangerously large deflections.
Author
Aeroelasticity; Air Flow; Aircraft Carriers; Flow Distribution; Helicopters; Rotary Wings; Rotor Blades; Wind Effects; Wind Tunnel Tests

19960020398 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
INTRODUCTION TO FLIGHT TEST ENGINEERING *INTRODUCTION A LA TECHNIQUE DESSAIS EN VOL*
Stoliker, F. N., Stoliker (F. N.), USA; Sep. 1995; 458p; In English
Report No.(s): AGARD-AG-300-VOL-14; ISBN 92-836-1020-2; Copyright Waived; Avail: CASI; A20, Hardcopy; A04, Microfiche

This is the Introductory Volume to the Flight Test Techniques Series. It is a general introduction to the various activities and aspects of Flight Test Engineering that must be considered when planning, conducting, and reporting a flight test program. Its main intent is to provide a broad overview to the novice engineer or to other people who have a need to interface with specialists within the flight test community. The first two Sections provide some insight into the question of why flight test and give a short history of flight test engineering. Sections 3 through 10 deal with the preparation for flight testing. They provide guidance on the preliminary factors that must be considered; the composition of the test team; the logistic support requirements; the instrumentation and data processing requirements; the flight test plan; the associated preliminary ground tests; and last, but by no means least, discuss safety aspects. Sections 11 through 27 describe the various types of flight tests that are usually conducted during the development and certification of a new or modified aircraft type. Each Section offers a brief introduction to the topic under consideration, and the nature and the objectives of the tests to be conducted. It lists the test instrumentation (and, where appropriate, other test equipment and facilities) required, describes the test maneuvers to be executed, and indicates the way in which the test data is selected, analyzed, and presented. The various activities that should take place between test flights are presented next. Items that are covered are: who to debrief; what type of reports to send where: types of data analysis required for next flight; review of test data to make a comparison to predicted data and some courses of action if there is not good agreement; and comments on selecting the next test flight. The activities that must take place upon completion of the test program are presented. The types

of reports and briefings that should take place and a discussion of some of the uses of the flight test data are covered. A brief forecast is presented of where present trends may be leading.
Author
Flight Tests; Flight Safety; Test Equipment; Project Management

19960020736 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
WIDESPREAD FATIGUE DAMAGE IN MILITARY AIRCRAFT *LENDOMMAGEMENT EN FATIGUE DES AVIONS MILITAIRES*
Dec. 1995; 224p; In English; 80th Meeting of the AGARD Structures and Materials Panel, 10-11 May 1995, Rotterdam, Netherlands; See also 19960013191 through 19960013209; Original contains 2 color illustrations
Report No.(s): AGARD-CP-568; ISBN 92-836-1021-0; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

Several countries have been experiencing aging aircraft related problems in their military fleets, particularly among their military transport aircraft. The most troubling aging aircraft structure-related issue is widespread fatigue damage (WFD), sometimes termed as multiple site damage, whose onset due to fatigue causes a dramatic structural strength reduction. Invariably, when WFD occurs, the affected model in the fleet is subjected to an extensive modification program which is almost always expensive and time-consuming. A Specialists' Meeting on the subject was held in order to explore ways and means to quantitatively predict structural degradation on account of WFD as a function of usage and when WFD is likely to occur.
Author
Fatigue (Materials); Degradation; Structural Analysis; Aircraft Structures; Aircraft Maintenance; Fatigue Life; Conferences

19960020737 Aeronautical Systems Div., Wright-Patterson AFB, OH United States
OVERVIEW OF WIDESPREAD FATIGUE DAMAGE: RISK ASSESSMENT METHODOLOGY
Lincoln, John W., Aeronautical Systems Div., USA; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 12p; In English; See also 19960020736; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The USA Air Force has used the probabilistic method to determine the onset of widespread fatigue damage in its aircraft for the past twenty years. They have focused their efforts on the loss of damage tolerance capability for both monolithic and fail-safe structures. The application of the probabilistic method requires that the appropriate data bases be estimated. The USAF generated these data bases through teardown inspections and from the operational usage tracking programs. The purpose of this paper is to provide an overview of the methodology for the probabilistic approach through risk assessments performed on USAF aircraft. These risk assessments provided the basis to make the appropriate aircraft modifications for elimination of this problem. In addition, a sample problem illustrating some of the essential data requirements for these analyses and the consequences of the results will be discussed.
Author
Fatigue (Materials); Risk; Tolerances (Mechanics); Aircraft Structures; Damage Assessment; Prediction Analysis Techniques

19960020738 National Research Council of Canada, Structures Materials and Propulsion Lab., Ottawa, Ontario Canada
A SPECIAL UNIAXIAL COUPON TEST SPECIMEN FOR THE SIMULATION OF MULTIPLE SITE FATIGUE CRACK GROWTH AND LINK-UP IN FUSELAGE SKIN SPLICES
Eastaugh, G. F., National Research Council of Canada, Canada; Simpson, D. L., National Research Council of Canada, Canada; Straznicky, P. V., Carleton Univ., Canada; Wakeman, R. B., Carleton Univ., Canada; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 20p; In English; See also 19960020736; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper reviews the loading and fatigue characteristics of longitudinal fuselage splices, and presents a specification and design concept for a uniaxial coupon test specimen that is intended to simulate these characteristics at low cost relative to full-scale panel and fuselage test articles. In particular, the specimen is intended to simulate the initiation, growth and link-up of multiple site fatigue damage (MSD). This simulation cannot be done with conventional coupon splice specimens. For proof-of-concept testing, the MSD specimen was tailored to be roughly representative of current narrow-body jet transport aircraft, using limited aircraft stress and other data available in the open literature. The results indicate that the specimen concept can fulfill its intended purpose. It would now be appropriate to apply the MSD specimen concept to a specific aircraft, in collaboration with the aircraft manufacturer. A procedure for tailoring the MSD specimen to a particular aircraft is proposed.
Author
Crack Propagation; Fatigue (Materials); Fuselages; Aircraft Structures; Load Tests; Crack Initiation; Stress Distribution

19960020740 Aero Vodochody A.S., Structural Integrity Dept., Odolena Voda, Czechoslovakia
WIDESPREAD FATIGUE DAMAGE AND SINGLE MEMBER FAILURE PREDICTION OF MILITARY JET TRAINERS OF CZECH DESIGN AND PRODUCTION
Fidransky, Jiri, Aero Vodochody A.S., Czechoslovakia; Fiala, Jiri, Aero Vodochody A.S., Czechoslovakia; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 12p; In English; See also 19960020736; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Military jet trainers originally designed under safe life concept are approaching in a lot of cases their service life estimates, based on 20 year old analyses and tests. The fleet condition and upgraded service spectra evaluation enables a significant life extension, because of safety margins of former approach. The Czech designed and produced L-39/59 jet trainer has been submitted to the Aircraft Structure Integrity Program (ASIP) with the main goal to extend the service life. As an essential tool for confirmation of the results the full-scale tests have been used. Widespread fatigue damage (WFD) has arisen during the tests on several areas of primary structure, but at least three service lives were without significant damage. In one case there was the phenomenon limiting the fatigue life of the component. In other cases fatigue life was significantly influenced, but widespread fatigue can be used as an indicator of possible damage of a single load path. The acoustic loading was the source of the significant WFD of the engine air intake duct. That is the only WFD occurred in service. Analytical techniques failed in several cases in prediction of WFD so far, but prediction of damage propagation on the stiffened panels still continues. The inspection periods and repair techniques were verified during the tests. to avoid possible structure damage, nondestructive inspection and Individual Aircraft Tracing (IAT) were introduced into maintenance procedures. The skin damage, caused by WFD, was successfully repaired in several cases by composite patches.
Author
Aircraft Structures; Damage; Failure Analysis; Fatigue (Materials); Fatigue Life; Inspection; Service Life; Aircraft Maintenance

19960020741 Georgia Inst. of Tech., Computaitonal Mechanics Center., Atlanta, GA United States
ANALYSIS OF AIRCRAFT PANELS WITH WFD, BASED ON THE ELASTIC PLASTIC FINITE ELEMENT ALTERNATING METHOD (EPFEAM) AND T*(SUB EPSILON) INTEGRAL
Pyo, C. R., Georgia Inst. of Tech., USA; Okada, H., Georgia Inst. of Tech., USA; Atluri, S. N., Georgia Inst. of Tech., USA; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 10p; In English; See also 19960020736; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Structural integrity evaluation of aging transport aircraft structures is extremely important to insure their economic and safe operation. In an airliner fuselage, pressurization causes stresses in the shell structure. The stiffening elements, such as stringers, frames and tear strips, take a part of the load but the major fraction is taken by the skin, for a typical fuselage structure. A typical situation of Multiple Site Damage (MSD) is the existence of multiple cracks of arbitrary lengths emanating from a row of fastener holes in a bonded, riveted joint in a pressurized fuselage. This problem has been the object of a number of studies in assessing the structural integrity of aging airplanes because the residual strength of a structure with a single crack may significantly be reduced by the existence of adjacent smaller cracks. In this paper, new analytical methods (Elastic Plastic Finite Element Alternating Method (EPFEAM)) for predicting the residual strength of a ductile panel with a row of cracks, and their results are presented. The alternating method is based on an analytical modeling of cracks and on an iterative procedure to satisfy the required boundary conditions for the body under consideration. A finite element solution is required only for the problem without cracks. A very fine mesh pattern

used in usual FEM is not necessary. The EPFEAM that uses the elastic alternating method in conjunction with the initial stress method as an elastic plastic algorithm, is extended in this paper to analyze stably propagating MSD cracks and their link up. The crack extension is modeled by releasing the cohesive traction ahead of the crack-tip based on an analytical solution. Thus, unlike the more common finite element nodal release technique, the amount of crack growth at any time is independent of the finite element mesh discretization. Among the various fracture criteria to model the crack growth, the T*(sub epsilon) integral, based on the equivalent domain integral (EDI), is employed. The procedures of the elastic-plastic finite element alternating method (EP-FEAM) are described in this paper for stationary as well as for stably propagating MSD cracks. Some numerical examples are presented, illustrating the residual strength estimations for a panel with MSD. The analytical results based on the stationary and stable crack propagation analyses are compared. and their differences in their residual strength predictions are also discussed.
Derived from text
Aircraft Structures; Crack Propagation; Cracks; Finite Element Method; Structural Failure; Residual Strength; Structural Analysis; Prediction Analysis Techniques

19960020744 Dayton Univ. Research Inst., OH United States
RISK ANALYSIS IN THE PRESENCE OF CORROSION DAMAGE
Berens, A. P., Dayton Univ. Research Inst., USA; Burns, J. G., Wright Lab., USA; Dec. 1995; 10p; In English; See also 19960020736; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

To quantify the potential damaging effects of corrosion in an aging fleet of aircraft, a structural risk analysis computer code was used to calculate the probabilities of fracture under statically defined corrosion scenarios. The analysis was performed using results from a damage tolerance evaluation of a critical location on an observation class, ground support aircraft. A realistic equivalent initial flaw size distribution was assumed for the start of the analysis. Corrosion condition, defined in terms of five and ten percent thickness loss, were imposed for two subsequent periods in the life of the aircraft. The effects of detecting and repairing or not detecting the corrosion were modeled. For the scenarios and conditions assumed in this analytical sensitivity study, undetected corrosion effects led to order of magnitude increases in risk. These results indicate that corrosion damage could well impact safety in the aging aircraft fleets.
Author
Risk; Aircraft Safety; Aircraft Maintenance; Stress Corrosion Cracking; Structural Analysis; Damage Assessment; Probability Theory; Applications Programs (Computers)

19960020745 Aeronautical Systems Div., Wright-Patterson AFB, OH United States
RISK ASSESSMENT OF AN AGING MILITARY TRAINER AIRCRAFT
Lincoln, John W., Aeronautical Systems Div., USA; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 12p; In English; See also 19960020736; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The paper examines the adequacy of the U.S. Air Force damage tolerance inspection criterion for protecting the safety of the flight of an aging military trainer aircraft. This is done through a risk assessment on the basis of cracks found in teardown inspections of retired wings. The crack population is combined with stress probabilities representing service experience to determine single flight probability of failure and the single aircraft probability of failure at a given time. These quantities are then used as a basis for judging the required inspection interval. For the case studied, the 0.9 probability of detection inspection criterion in the Air Force damage tolerance requirements may be unconservative.
Author
Risk; Reliability Analysis; Inspection; Aircraft Maintenance; Damage Assessment; Tolerances (Mechanics); Training Aircraft; Military Operations; Structural Analysis; Probability Theory

19960020746 Lockheed Aeronautical Systems Co., Marietta, GA United States
DESTRUCTIVE TEARDOWN OF A C-141 LOWER INNER WING SURFACE
Cochran, J. B., Lockheed Aeronautical Systems Co., USA; Bell, R. P., Lockheed Aeronautical Systems Co., USA; Weitz, G. M., Lockheed Aeronautical Systems Co., USA; Alford, R. E., Lockheed Aeronautical Systems Co., USA; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 6p; In English; See also 19960017026; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

As part of a structural assessment of the C-141 aircraft for life extension feasibility, the USA Air Force Scientific Advisory Board (SAB) directed a teardown inspection on a high time C-141 inner wing lower surface. The teardown inspection was performed at Lockheed Aeronautical System Company (LASC), Marietta, GA, in 1993. This paper will address the following: (1) why was the teardown required?; (2) the condition of the aircraft before the teardown; (3) teardown procedure; and (4) how the results of the teardown were used. The teardown program was performed over six months. Eight thousand, seven hundred and sixty-two holes on the right wing were inspected by automatic bolt hole eddy current (ABHEC). One hundred and fifty-three flaws were detected initially, with the final number of two hundred and eighty-nine confirmed flaws. The results of the teardown were used by the Air Force to carry out an inspection/repair program that maintained a safe operational environment for the C-141B aircraft.
AIAA
C-141 Aircraft; Dynamic Structural Analysis; Wing Panels; Nondestructive Tests; Surface Cracks; Cracking (Fracturing); Holes (Mechanics); Performance Prediction

19960020747 Tsentralni Aerogidrodinamicheskii Inst., Moscow, USSR
MULTIPLE SITE FATIGUE DAMAGES OF AIRCRAFT STRUCTURES
Nesterenko, G. I., Tsentralni Aerogidrodinamicheskii Inst., USSR; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 8p; In English; See also 19960020736; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A methodology for ensuring the damage tolerance of aircraft structures with multiple site fatigue damages is reported. Examples of such damage in wings and fuselages in the course of fatigue strength certification tests and in service are shown. Residual strength criteria for such structures are provided.
Author
Damage Assessment; Fatigue (Materials); Structural Analysis; Wings; Fuselages; Cracking (Fracturing); Tolerances (Mechanics)

19960020748 Defence Research Agency, Farnborough, Structures Dept., Hampshire, United Kingdom
AVOIDING WFD: A GUIDE TO THE FATIGUE DESIGN REGULATIONS FOR BRITISH MILITARY AIRCRAFT
Cardrick, Arthur, Defence Research Agency, Farnborough, UK; Dec. 1995; 12p; In English; See also 19960020736; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The loss some years ago of a large section of the cabin roof from an aging Boeing 737 thrust the specter of Widespread Fatigue Damage (WFD) into the public domain and gave new impetus to regulations for preventing fatigue life from being undermined by corrosion or repairs. This paper begins with some examples of major fatigue tests in which classical WFD failures have occurred and goes on to consider how the Fatigue Regulations for British Military Aircraft combat the threat presented by WFD as well as the wider threats presented by corrosion, repairs and increases in the severity of service loading. The paper closes by illustrating how the antithesis of WFD - damage concentrated in just one location - might be used to improve the safety and durability of future designs.
Author
UK; Military Aircraft; Fatigue (Materials); Damage Assessment; Regulations; Case Histories; Fatigue Tests; Aircraft Maintenance

19960020749 Monash Univ., Dept. of Mechanical Engineering., Clayton, Australia
LIVING WITH WIDE SPREAD FATIGUE DAMAGE
Jones, R., Monash Univ., Australia; Wilson, E. S., Royal Australian Air Force, Australia; Hammond, S., Monash Univ., Australia; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 10p; In English; See also 19960020736; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The purpose of this paper is to address Australian experiences in the field of wide spread fatigue damage (WSFD). The examples

presented in this paper deal with WSFD in Mirage, Macchi, F111C and F/A-18 aircraft, and were specifically chosen so as to highlight future assessment and certification requirements.
Author
Military Aircraft; Fatigue (Materials); Crack Propagation; Fatigue Tests; Cracking (Fracturing); Aircraft Structures; Damage Assessment

19960020750 Dassault Aviation, Saint-Cloud, France
DAMAGE TOLERANCE TO WFD (WIDESPREAD FATIGUE DAMAGE) ON COMBAT AIRCRAFT: AN APPLICATION TO A METALLIC WING LOWER PANEL
Cazes, R. J., Dassault Aviation, France; Goerung, F., Dassault Aviation, France; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 14p; In English; See also 19960020736; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Maintaining the structural integrity of aircraft in prolonged service requires consideration to be given to inspections for detecting possible multiple damage. This paper presents an assessment of the structural behavior of a (metallic) underwing panel of which several bays between stiffeners may be corroded both on their surface and within their thickness. The analysis of tolerance to damage highlights the importance of statistical feedback from inspections for establishing hypothesis of structural damage with which to predict behavior, and highlights the particular attention to be paid to structures in a saline or corrosive environment.
Author
Fatigue (Materials); Wing Panels; Metal Surfaces; Corrosion Prevention; Fighter Aircraft; Aircraft Structures; Structural Failure; Crack Propagation; Skin (Structural Member); Cracking (Fracturing)

19960020751 Industrieanlagen-Betriebsgesellschaft m.b.H., Structures Tests and Technology TAS., Ottobrunn, Germany
FATIGUE DAMAGES DURING TORNADO MAF TEST
Broecker, W., Industrieanlagen-Betriebsgesellschaft m.b.H., Germany; Buderath, M., Daimler-Benz Aerospace A.G., Germany; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 8p; In English; See also 19960020736; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Some of the fatigue damages which have occurred during the major airframe fatigue test (MAF-Test) of TORNADO fighter aircraft seemed to be wide spread fatigue damages (WFD). These damages accompanied by results from coupon tests will be presented and analyzed in this paper. This paper will confirm that the load transmission in bolted splice sections is a rather complex phenomenon. The fatigue behavior of a bolted joint/splice is dependent on many parameters, as there are different designs, materials and fastener types used. Because there is still not abundance of information available about the WFD problem, the inspections of bolted joints with respect to aging aircraft should be based on coupon tests or better still on full scale fatigue tests.
Author
Fighter Aircraft; Fatigue Tests; Airframes; Bolted Joints; Full Scale Tests; Crack Propagation; Cracking (Fracturing); Damage Assessment

19960020752 Instituto Superior Tecnico, Dept. Engenharia Mecanica., Lisbon, Portugal
DAMAGE TOLERANCE EVALUATION ON THE A7-P AIRCRAFT CONSIDERING THE POAF USAGE
deFreitas, Manuel, Instituto Superior Tecnico, Portugal; Fonseca, Agostinho, Instituto Superior Tecnico, Portugal; Goncalo, Humberto, Portuguese Air Force, Portugal; Pires, Carvalho, Portuguese Air Force, Portugal; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 8p; In English; See also 19960020736; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

An exploratory and preliminary damage tolerance evaluation on the A7-P Corsair is presented. The stress data was obtained through the data acquisition system installed in two aircraft in PoAF fleet. Forman's law and Wheeler retardation model were used on a crack propagation simulation of cracks emanating from a hole in the wing lower skin. The material fatigue data was originally generated by Vought Corporations, the aircraft manufacturer. The results show the influence of multiple crack initiation and propagation on the predicted fatigue life of the A7-P aircraft.
Author
Military Aircraft; Crack Propagation; Aircraft Structures; Wings; Skin (Structural Member); Crack Initiation; Fatigue Life; Damage Assessment; Cracking (Fracturing); Regression Analysis

19960020753 Saab Aircraft Co., Military Aircraft Div., Linkoeping, Sweden
WIDESPREAD FATIGUE DAMAGE IN COMBAT AIRCRAFT
Ansell, Hans, Saab Aircraft Co., Sweden; Johansson, Thomas, Saab Aircraft Co., Sweden; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 12p; In English; See also 19960020736; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Most attention to Widespread Fatigue Damage (WFD) has for obvious reasons been focused on the transport aircraft category. For such aircraft many of the prerequisite for WFD to occur are present. Colinear structure, stress field close to uniform, thin sheet sections and almost constant amplitude loading are all conditions that make some primary transport aircraft structures prone to develop WFD. In combat aircraft, these conditions are not so easily identified and not always present all together at the same time. An inventory has been done of combat aircraft wing-structure that may have the potential to develop WFD. Saab combat aircraft designed during the 50's and 60's have been studied. Structures have been selected according to a set of conditions that may be important for WFD to develop. The design and stresses of such structure are discussed in view of available full-scale test results of presence or non-presence WFD.
Author
Saab Aircraft; Wings; Full Scale Tests; Fighter Aircraft; Aircraft Structures; Skin (Structural Member); Fatigue Tests; Damage Assessment; Crack Propagation; Stress Distribution

19960020754 Royal Air Force, Logistics Command., Huntingdon, United Kingdom
THE EFFECT OF PROOF PRESSURE TESTING ON THE RETARDATION OF MULTI-SITE DAMAGE
Bittel, E., Royal Air Force, UK; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 8p; In English; See also 19960020736; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A range of laboratory specimens, representative of pressurized fuselage structures, were tested under constant amplitude loading to provide data for comparison with theoretical predictions. A proportion of specimens were subjected to single overload cycles. The theoretical model was based on recognized methods of contemporary fracture mechanics, allied to a simple but effective technique for modeling the growth behavior of a fatigue crack following an overload cycle. Good agreement was noted between predictions and experimental results, and recommendations for further development of the model are being formulated.
Author
Crack Propagation; Stress Intensity Factors; Fatigue (Materials); Cyclic Loads; Cracking (Fracturing); Fatigue Tests; Aircraft Structures; Fuselages; Transport Aircraft; Mathematical Models

19960020814 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
ADVANCED AEROSERVOELASTIC TESTING AND DATA ANALYSIS *LES ESSAIS AEROSERVOELASTIQUES ET L'ANALYSE DES DONNEES*
Nov. 1995; 282p; In English; In French; 80th Meeting, 8-10 May 1995, Rotterdam, Rotterdam, Netherlands, Netherlands; See also 19960020815 through 19960020835
Report No.(s): AGARD-CP-566; ISBN 92-836-0017-17; Copyright Waived; Avail: CASI; A13, Hardcopy; A03, Microfiche

The papers presented at the AGARD Structures and Materials Panel's Specialists' Meeting on Aeroservoelastic Testing and Data Analysis, held in Rotterdam in May 1995 are included. Flutter is a potentially catastrophic aeroelastic dynamic instability. Flight flutter tests are conducted to demonstrate freedom from flutter for critical aircraft conditions and to derive data to validate the flutter analysis. Active control systems (ride control, gust load alleviation, flutter stabilization, etc.) add to the scope and complexity of these tests in that control system instability due to aeroservoelastic interactions must

also be considered. The conclusions of the meeting are that most of the tests need improvements, some tests should be better exploited, and at least one test, the in-flight measurement of unsteady air loads, should become standard practice to close a gap in the logic of flutter certification.
Author
Flight Control; Aeroservoelasticity; Flutter; Flutter Analysis; Flight Tests; Wind Tunnel Tests; Dynamic Response; Aerodynamic Stability; Structural Vibration; Conferences

19960020815 NASA Dryden Flight Research Center, Edwards, CA United States
A HISTORICAL OVERVIEW OF FLIGHT FLUTTER TESTING
Kehoe, Michael W., NASA Dryden Flight Research Center, USA; Advanced aeroservoelastic testing and data analysis; Nov. 1995; 16p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper reviews the test techniques developed over the last several decades for flight flutter testing of aircraft. Structural excitation systems, instrumentation systems, digital data preprocessing, and parameter identification algorithms (for frequency and damping estimates from the response data) are described. Practical experiences and example test programs illustrate the combined, integrated effectiveness of the various approaches used. Finally, comments regarding the direction of future developments and needs are presented.
Author
Aeroelasticity; Flutter; Flight Tests; Data Reduction; Aerodynamic Stability; Aircraft Performance; Structural Vibration

19960020816 Daimler-Benz Aerospace A.G., Structural Dynamics Group., Munich, Germany
FLUTTER FLIGHT TEST OF THE RANGER 2000 AIRCRAFT
Weiss, F., Daimler-Benz Aerospace A.G., Germany; Schweiger, J., Daimler-Benz Aerospace A.G., Germany; Hoenlinger, H., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Nov. 1995; 10p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper describes the flight flutter test activities for the RANGER 2000 training aircraft, which was jointly developed by DASA and Rockwell International between 1991 and 1994 as a competitor for the next generation U.S. Air Force and Navy Joint Primary Advanced Training System (JPATS). After a brief description of the program and the main aircraft features, an overview of the aeroelastic analysis and the ground vibration tests during the design process are given. The report of the flight test activities is divided into the description of the test equipment, aircraft instrumentation, flight envelope, test procedures, realtime telemetry monitoring and post-flight data reduction. Typical time histories of response, frequency response functions, power spectra and typical plots of the frequencies and damping versus dynamic pressure are given. The flight test results in combination with the aeroelastic analysis are discussed at the end.
Author
Training Aircraft; Flight Tests; Flutter; Power Spectra; Frequency Response; Vibration Damping; Dynamic Pressure; Aeroelasticity; Aerodynamic Stability; Structural Vibration; Forced Vibration

19960020817 Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost, Netherlands
FLIGHT FLUTTER TESTING OF A TURBO-PROP AIRCRAFT BY USING EXTERNAL EXCITATION DEVICES
Schippers, P., Royal Netherlands Aircraft Factories Fokker, Netherlands; Persoon, A. J., National Aerospace Lab., Netherlands; Advanced aeroservoelastic testing and data analysis; Nov. 1995; 12p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In modern flutter testing of aircraft artificial excitation is applied. A recently developed aerodynamic vane has been tested in a preliminary flight test to become familiar with installation and use. Two of these vanes have been applied at flutter testing of an configuration of the Fokker 50 Mk2S. Some results of the flight tests and properties of the aerodynamic vane are highlighted.
Author
Flight Tests; Flutter; Fokker Aircraft; Power Spectra; Aerodynamic Stability; Forced Vibration; Vanes; Structural Vibration

19960020818 Department of the Air Force, Compatibility Engineering Flight Munitions Test Division., Eglin AFB, FL United States
US AIR FORCE/DEI FLUTTER EXCITER TEST PROGRAM
Shirley, B. M., Department of the Air Force, USA; Anderson, E. L., Tybrin Corp., USA; Advanced aeroservoelastic testing and data analysis; Nov. 1995; 10p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

USA Air Force (USAF) testing of the Dynamic Engineering Incorporated (DEI) flutter exciter was conducted in Jul. - Sept. 1993, using pylon-mounted exciters on an existing F-16A flutter test aircraft. The intent was to evaluate the system as a low-cost, easily-installed alternative to the existing aircraft flight control integrated systems. A dual exciter system with an exciter mounted on the outboard side of each weapons pylon (aircraft weapons stations 3 and 7) was flight tested in conjunction with the existing integrated Flutter Exciter System (FES). The existing F-16 system provides excitation via the flaperons; it is capable of symmetric and antisymmetric sweeps and bursts of up to 20 Hz for selectable time durations. Testing of the DEI flutter exciter system was limited to matching FES time/frequency capabilities, although it has greater frequency response and time duration capabilities. A one-for-one comparison of excitation levels, frequency content and damping values was made at various Mach/airspeed/altitude combinations for five different aircraft/weapon configurations, three of which are presented herein. Conclusions are drawn regarding (1) the use of the DEI exciter in a high-q environment; and (2) its application as an alternative excitation method.
Author
F-16 Aircraft; Flutter; Structural Vibration; Aerodynamic Stability; Flight Tests; Frequency Response; Forced Vibration; Power Spectra

19960020819 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Inst. of Aeroelasticity., Goettingen, Germany
STATUS ON STRATO 2C FLIGHT FLUTTER TESTING ACTIVITIES
Kiessling, F., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Rippl, M., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Hoenlinger, H., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Nov. 1995; 8p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The STRATO 2C aircraft is currently being developed for manned stratospheric research missions up to 80,000 ft. It is powered by two 330 kW turbo-charged piston engines. The requirements for flight endurance, altitude, payload, and operating range can only be met if high aerodynamic quality, high propulsion efficiency, and low empty weight are achieved simultaneously. The large wing span (56.5 m) and aspect ratio (21.3) result from aerodynamic optimization. Carbon fiber composites are applied to reduce weight and deflections. Possible aeroelastic problems are dealt with during aircraft development. This paper gives an overview on these activities. When considering its flutter proneness, STRATO 2C may be compared with modern high-performance sailplaines. However, this analogy fails when taking into account its size, operating altitude, and large wing mounted nacelles with pusher propellers. In the early stages, a modal survey test on the stabilizer spar box similar to that of the wing was performed to check finite-element modeling assumptions. The idealization of the complete aircraft leads to a verified model which is used for aeroelastic predictions for various configurations without excessive test efforts. A ground vibration test on the proof-of-concept aircraft serves as the main experimental data base. The flutter analysis includes the design of control surface mass balance and attachment flexibility. The five-bladed wood/composite propellers with a size of 6 m in diameter are constrained to minimum weight. Two types of aeroelastic vibrations were observed in the first windtunnel tes and were identified as blade flutter and forced response at yawed flow conditions, respectively. An improved design was checked by analytical comparison based on modal test data. Whirl flutter is possible with large elastically mounted propellers operating at high advance ratios. This subject is briefly addressed in this paper.
Author
Flutter; Research Aircraft; Vibration Tests; Flight Tests; Flutter Analysis; Aeroelasticity; Dynamic Response; Forced Vibration; Aerodynamic Stability

19960020820 National Research Council of Canada, Inst. for Aerospace Research., Ottawa, Ontario Canada
AEROELASTIC TESTING OF AN UNMANNED AIR VEHICLE
Lee, B. H. K., National Research Council of Canada, Canada; Plosenski, M. J., National Research Council of Canada, Canada; Barrington, P. E., Carleton Univ., Canada; Markov, A. B., Defence Research Establishment Suffield, Canada; Coffey, C. G., Defence Research Establishment Suffield, Canada; Nov. 1995; 16p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A full scale unmanned air vehicle (HATT-X) was tested in an open jet wind tunnel facility. Strain gauges were installed on the canard shafts to measure the unsteady aerodynamic loads. The data was recorded on a high speed data acquisition system for off-line analysis. High speed photography was also used to study the canard motion. A destructive 57 Hz canard flutter was observed at a Mach number of approximately 0.75 and dynamic pressure of 5.95 psi for a canard incidence angle of approximately 4 deg. A mass balances and stiffer canard was manufactured and installed on the HATT-X. A flight test on the modified HATT-X was conducted. Approximately 2 second after initiation of the stage 7 motor burn, large vertical oscillations of the port side canard were detected, followed by the structural failure of the canard linkage system in the forward fuselage. At the failure point the vehicle was decelerating after the rocket motor burn and the Mach number was approximately 0.75. Failure of the canard system was investigated and where possible comparisons were made of the aeroelastic behavior in the wind tunnel and flight tests of the two canards that are structurally different.
Author
Wind Tunnel Tests; Flight Tests; Flutter; Unsteady Aerodynamics; Structural Failure; Canard Configurations; Aeroelasticity; Structural Vibration; Aerodynamic Coefficients; Remotely Piloted Vehicles; Research Aircraft

19960020821 Wright Lab., Flight Dynamics Directorate., Wright-Patterson AFB, OH United States
DESIGN AND TESTING OF AN AEROELASTICALLY SCALED MODEL STRUCTURE
French, Mark, Wright Lab., USA; Eastep, F. E., Dayton Univ., USA; Nov. 1995; 12p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

An approach has been developed which uses optimization methods to automate wind tunnel model design. The model design process has been divided into separate stiffness design and mass design stages. Then, a sample structure was manufactured and subjected to static and modal testing using laser holographic techniques. Optical test methods are well suited to testing subscale models. A single image shows either static or dynamic out of plane deflections for the entire model. These methods reduced the time required to characterize the test specimen compared to more conventional methods and did so with improved accuracy.
Author
Parameter Identification; Wind Tunnel Models; Scale Models; Static Tests; Dynamic Tests; Finite Element Method; Design Analysis; Aeroelasticity

19960020823 Manchester Univ., School of Engineering., United Kingdom
PARAMETER ESTIMATION METHODS FOR FLIGHT FLUTTER TESTING
Cooper, J. E., Manchester Univ., UK; Nov. 1995; 12p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This article presents a review and assessment of the various techniques that have been used to estimate modal parameters from flight flutter test data. The relative advantages and disadvantages of the methods are examined, with particular emphasis being given to their suitability for analyzing flutter test data. The problems associated with analyzing non-linear and aeroservoelastic test data are highlighted. Recent advances in modal parameter identification are considered in terms of their relevance to flight flutter testing. Finally, future requirements for the analysis of flight flutter test data are discussed.
Author
Flight Tests; Flutter; Aeroservoelasticity; Parameter Identification; Modal Response; Structural Vibration

19960020824 Canadair Ltd., Administrative Center., Dorval, Quebec Canada
CF-18 FLIGHT FLUTTER TEST (FFT) TECHNIQUES
Dickinson, M., Canadair Ltd., Canada; Nov. 1995; 10p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The paper describes Canadair's role in the flight flutter testing of the CF-18 aircraft for the Canadian Forces. The flight test programs are flown from AETE Cold Lake Alberta, and are a partnership between Canadair and AETE. The 1992 category 2 480 gallon EFT FFT program is used as a detailed example of this Canadair role. The paper emphasizes the FFT techniques currently employed, and the difficulties encountered due to non-linear modal behavior and a transonic EFT buffet condition. The test program marked the first FFT application of AETE's LMS frequency analysis system. The paper describes the user programs developed to tailor and automate this system for CF-18 FFT use. The programs are written in the LMS UPA language and were largely developed as the FFT program progressed. The results from two separate FFT data reduction techniques (dwell-decay PSD, and FRF / MLE curvefitting) are directly compared with the preflight FEM predictions. The differences in the two sets of FFT results are explained by studying a simple Log-Dec analysis of a response decay.
Author
Canadair Aircraft; Flight Tests; Flutter; Applications Programs (Computers); Frequency Response; Modal Response; Vibration Tests; F-18 Aircraft

19960020825 LMS International, Leuven, Belgium
A MAXIMUM LIKELIHOOD PARAMETER ESTIMATION TECHNIQUE TO ANALYSE MULTIPLE INPUT/MULTIPLE OUTPUT FLUTTER TEST DATA
VanderAuweraer, H., LMS International, Belgium; Guillaume, P., Vrije Univ., Belgium; Nov. 1995; 8p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In this paper, the formulation of the maximum likelihood SISO (Single Input / Single Output) estimator (ELiS) is generalized for MIMO (Multiple Input / Multiple Output) systems. The behavior of the two ML estimators is compared when applied to real and synthetic data. The following conclusions can be drawn. When a mechanical structure is excited at different places or/and the response is monitored at several points, the MIMO estimator can extract more information out of the measurements than the SISO estimator. The gain obtained by using the MIMO estimator is essentially due to the assumption of global parameters in the transfer function matrix. The result is independent of the estimation method used. Usually it is assumed that the transfer functions of the transfer function matrix equation all have common poles. The more links the better the interaction among the measurements. In one of the test cases, it was therefore possible to estimate a pole-zero pair which was completely hidden by the noise thanks to the information present in the input-output measurements related to the other transfer functions. Due to the relatively large amount of data processed by the MIMO estimator, the asymptotic properties of the ML estimators are reached sooner. When the input signals are correlated, the SISO estimator cannot be used without introducing supplementary errors.
Author
Maximum Likelihood Estimates; Parameter Identification; Flutter; MIMO (Control Systems); SISO (Control Systems); Flight Tests; Transfer Functions; Structural Vibration

19960020826 Manchester Univ., School of Engineering., United Kingdom
ADVANCES IN THE ANALYSIS OF FLIGHT FLUTTER TEST DATA
Cooper, J. E., Manchester Univ., UK; Desforges, M. J., Manchester Univ., UK; Emmett, P. R., Manchester Univ., UK; Wright, J. R., Manchester Univ., UK; Nov. 1995; 12p; In English; See also 19960020814;

Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A number of methods developed with the aim of improving the analysis and interpretation of flight flutter test data are described. The approaches are divided into improved curve fitting techniques and methods for enabling increased confidence in the flutter clearance procedure. Real and simulated flight flutter data are used to illustrate the various approaches.

Author

Flight Tests; Flutter; Aerodynamic Stability; Curve Fitting; Frequency Response; Structural Vibration; Vibration Damping; Flutter Analysis

19960020828 Central Aerohydrodynamics Inst., Zhukovsky, Russia

SYSTEM OF AEROSERVOELASTIC EXPERIMENTAL AND NUMERICAL INVESTIGATIONS FOR AIRCRAFT DESIGN AND CERTIFICATION

Zitchenkov, M. Ch., Central Aerohydrodynamics Inst., Russia; Dovbishchuk, V. I., Central Aerohydrodynamics Inst., Russia; Popovsky, V. N., Central Aerohydrodynamics Inst., Russia; Nov. 1995; 12p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Solving practical problems of modern aeroservoelasticity (ASE) presumes accomplishing reasonable synthesis and reliable analysis of nonlinear analog-digital multi-dimensional electromechanical objects characteristics in frequency and time domains. This paper briefly describes the system of experimental and analytical research and certification used in the Russian aircraft industry to ensure aircraft safety from vibrations of various types due to the interaction between the airframe and flight control system as well as active control of aeroelastic dynamic deformations. The system provides qualitative determination and analysis of ASE characteristics for all aircraft development stages. Some real results obtained in ASE research programs on wide body civil and aerospace aircraft are presented as an illustration.

Author (revised)

Aeroservoelasticity; Aircraft Design; Active Control; Certification; Dynamic Stability; Structural Vibration; Flight Control

19960020830 Deutsche Airbus G.m.b.H., Bremen, Germany

PRETENSION AND REALITY OF FLUTTER-RELEVANT TESTS

Koenig, Klaus, Deutsche Airbus G.m.b.H., Germany; Nov. 1995; 12p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The paper gives a short review of all flutter-relevant tests of an a/c and discusses differences between the wanted and the reached reliability of the measured data. This includes weight measurements, stiffness tests, actuator impedance tests, tests of the Electronic Flight Control Systems (EFCS), Ground Vibration Tests (GVT), Flight Vibration Tests (FVT), in-flight measurements of unsteady airloads, and safety tests for active control systems. The conclusions are that most of the tests need some improvements, some tests should be better exploited, and at least one test, the in-flight measurement of unsteady airloads, should become standard practice to close a gap in the logic of flutter certification.

Author

Flutter; Flight Tests; Vibration Tests; Ground Tests; Electronic Control; Flight Control; Unsteady Aerodynamics; Forced Vibration

19960020831 British Aerospace Defence Ltd., Military Aircraft Div., Preston, United Kingdom

FLIGHT FLUTTER TESTING OF COMBAT AIRCRAFT

Ramsay, R. B., British Aerospace Defence Ltd., UK; Nov. 1995; 14p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A computer system for analysis and display of flutter parameters during flight flutter testing of an unstable digitally controlled fly-by-wire combat aircraft is presented. The system is being developed by BAe in conjunction with Parsytec GmbH, a computer company specializing in parallel processing hardware and software and applied to the Eurofighter 2000 (EF2000). The benefits will increase aircraft safety by identifying critical parameters involved in the flutter mechanisms during flight flutter testing, by increasing the visibility of data to the test engineer. The Parsytec system, which is part of the flight test ground station, is fully integrated with the telemetry facility and is capable of analyzing, confidencing and displaying test data for comparison with prediction in near-real time. This facility, which includes parallel processing transputers combined with high performance digital signal processing devices, will enable the engineer to assess analyzed data quickly and efficiently in order to decide whether or not the aircraft can safely progress the envelope expansion. In addition, an aircraft excitation system is being developed which will permit predefined waveforms, generated within the Flight Control Computers (FCC) to be summed into the Flight Control System (FCS) actuation loops under cockpit control. The overall clearance philosophy for identifying critical flutter parameters through calculations, ground testing, and flight testing is also presented.

Author

Fighter Aircraft; Flight Tests; Flutter; Computer Programs; Aircraft Safety; Parallel Processing (Computers); Flight Control; Fly by Wire Control; Aircraft Control; Airborne/Spaceborne Computers

19960020832 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik., Brunswick, Germany

THE EVOLUTION OF FLIGHT VEHICLE SYSTEM IDENTIFICATION

Hamel, Peter G., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Jategaonkar, Ravindra V., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Jategaonkar, Ravindra V., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Nov. 1995; 28p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Aircraft parameter estimation is probably the most outstanding and illustrated example of the system identification methodology, which provides answers to the age-old inverse problem of model determination and validation given a set of observations. After providing a brief account of historical background, the paper traces chronoligically the evolution of flight vehicle system identification starting from determination of aircraft frequency and damping ratio from flight data in the early twenties to the present day advanced applications such as estimation of high fidelity aerodynamic data bases for flight simulators or evaluation of highly augmented unstable flight vehicles of unconventional configurations. Through selected examples, it is demonstrated that the system identification methods have reached a maturity level that makes them a powerful and useful tool to support not only research but also industry activity in model validation, handling qualities evaluation, control law design, and flight vehicle design, and thus contribute significantly to risk and cost reduction in the optimal deployment of the existing aircraft and in the development of new generation aircraft. Although the paper focuses mainly on the applications in the area of flight mechanics, some aspects of interdisciplinary flight vehicle modeling, for applications such as aeroservoelasticity or high bandwidth rotorcraft modeling, are addressed as well.

Author

System Identification; Flight Mechanics; Aerodynamic Stability; Error Analysis; Data Reduction; Neural Nets; Parameter Identification; Flight Vehicles

19960020833 Northrop Grumman Corp., Bethpage, NY United States

ELEMENTS OF THE B-2 FLIGHT FLUTTER TEST PROGRAM

Britt, R. T., Northrop Grumman Corp., USA; Winther, B., Northrop Grumman Corp., USA; Nov. 1995; 8p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This presentation described the basic test techniques and analysis methodology utilized during the execution of the flutter flight test program on the USAF/Northrop B-2 stealth bomber aircraft. Key elements of the program that were presented included: excitation systems that used control surfaces and turbulence (with comments on actuator capabilities, bandwidth and rates, and digital system effects); the use of an on-board test panel to provide excitation inputs (sine sweep, dwells, and random inputs with full control over frequency, magnitude, rate, and spectrum shape); the simultaneous recording of all instrumentation signals (distributed accelerometers, strain gauges, and control surface deflections); methodologies used to provide modal frequency and damping estimates; and real-time data acquisition/analysis procedures with point-to-point clearance.

Author

B-2 Aircraft; Flutter; Flight Tests; Control Surfaces; Structural Vibration; Forced Vibration; Real Time Operation; Flutter Analysis

19960020835 Alenia Aeronautica, Defence Aircraft Engineering., Turin, Italy
GROUND STRUCTURAL COUPLING TESTING AND MODEL UPDATING IN THE AEROSERVOELASTIC QUALIFICATION OF COMBAT AIRCRAFT
Vaccaro, V., Alenia Aeronautica, Italy; Becker, J., Daimler-Benz Aerospace A.G., Germany; Nov. 1995; 12p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper is concerned with the role played by the ground Structural Coupling Test (SCT) and the update of the aeroservoelastic model in the qualification process of a modern combat aircraft. Most of modern aircraft are equipped with fly-by-wire and electronic Flight Control Systems (FCS). The problem of interaction between the dynamic response of the airframe and the FCS is usually solved through an appropriate set of notch filters, designed to attenuate the level of structural vibrations picked up by the FCS sensors. Fundamental part of the qualification of the notch filter set is the ground testing activity, generally known as ground structural coupling test. The main subject of this paper is the description of the test procedure followed for a delta-canard fly-by-wire aircraft. The peculiar aspect of this test was the identification of the coupling characteristics of the aircraft in the configuration with external stores. The final part of the paper deals with the utilization of the test results in the updating of the aeroservoelastic model. Emphasis is placed upon the necessity of an adequate model, in order to reduce the test activity to a limited set of external store configurations.
Author
Fighter Aircraft; Ground Tests; Aeroservoelasticity; Structural Vibration; Dynamic Response; Control Surfaces; Dynamic Models; Airframes; Feedback Control; Finite Element Method

19960022102 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
THE DESIGN, QUALIFICATION AND MAINTENANCE OF VIBRATION-FREE LANDING GEAR *LA CONCEPTION, LA QUALIFICATION ET LA MAINTENANCE DES TRAINS D'ATTERRISSAGE SANS VIBRATION*
Mar. 1996; 136p; In English; In French; 81st Meeting of the AGARD Structures and Materials Panel, 4-5 Oct. 1995, Banff, Canada; See also 19960022103 through 19960022111
Report No.(s): AGARD-R-800; ISBN 92-836-1032-6; Copyright Waived; Avail: CASI; A07, Hardcopy; A02, Microfiche

The Structures and Materials Panel of AGARD sponsored a Workshop focusing on the various vibrational and stability problems (e.g. shimmy, antiskid induced vibrations) that must be considered in the early design phase of landing gear systems, especially problems which are related to vibrations of the combined structural system formed by the landing gear, its tires and the flexible aircraft structure. The intention was to indicate the impact of (combined) landing gear/aircraft vibration problems on aircraft design and to discuss the state-of-the-art technology in this area and to define possible future steps of development.
Author
Landing Gear; Structural Vibration; Aircraft Structures; Aircraft Design; Damage Assessment; Aircraft Landing

19960022103 Lockheed Martin Aeronautical Systems, Marietta, GA, Unknown
PRELIMINARY DESIGN OPTIMIZATION OF CARRIER AND LAND BASED FIGHTER LANDING GEARS
Crenshaw, B. M., Lockheed Martin Aeronautical Systems, Marietta; Brown, Susan C., Lockheed Martin Aeronautical Systems, Marietta; The Design, Qualification and Maintenance of Vibration-Free Landing Gear; Mar. 1996; 16p; In English; See also 19960022102; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The differences in requirements of land based (LB) and carrier based (CB) aircraft landing gear are reviewed with respect to landing impact and ground surface roughness. Frequently the issue of operational roughness requirements vs. 'taxi' requirements arises. More often, it seems, attention is being focused on operational runway roughness requirements. The MILSPEC roughness amplitudes and wavelengths may not represent the operational capability of an aircraft when combined sources of loading are considered. There are severe loads on both main and nose gears during landing rollout on a rough runway surface if braking is used; however, levels of braking and roughness combinations are not always clearly defined in procurement specifications. The more robust landing gears sized for carrier operations are examined to determine their potential operational performance for land based roughness levels when combined loads from rollout braking are considered. While the weight penalty associated with carrier qualified landing gears is commonly recognized, and weight efficiency requirements of fighter aircraft may ultimately outweigh cost considerations for commonality of landing gear components, it is nevertheless worthwhile to consider methods for reducing costs through multiple application designs and parts usage. Although without great previous success, multi-service application of designs has long been an attractive concept. If severe runway roughness capability is considered as an operational requirement for land based gears, the weight obstacles to common landing gears may diminish. A hypothetical future fighter aircraft is utilized to compare runway roughness capability of gears sized for carrier landing and arrestment loads with gears sized exclusively for land based use, to compare relative landing gear weights, and to develop concepts of landing gears with the potential of multi-service usage. A simple forward retracting vertical post strut arrangement has been examined from a conceptual standpoint for low cost production in two stroke lengths.
Author
Landing Loads; Landing Gear; Structural Design Criteria; Aircraft Design; Impact Loads; Surface Roughness; Runways

19960022104 Wright Lab., Wright-Patterson AFB, OH United States
A REVIEW OF AIRCRAFT LANDING GEAR DYNAMICS
Krabacher, William E., Wright Lab., USA; The Design, Qualification and Maintenance of Vibration-Free Landing Gear; Mar. 1996; 12p; In English; See also 19960022102; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

A review of two different landing gear shimmy mathematical models is presented. One model uses the Moreland tire model and the other model uses the Von Schlippe-Dietrich tire model. The results of a parametric study using these models is presented indicating the sensitivity of various parameters to numerical variation. An identification of stability critical parameters in the models is given. Three different aircraft landing gear shimmy data sets are reviewed and model stability predictions are discussed. A comparison is made with actual experimental results. One of these data sets indicates the nonlinear variation of various input parameters as a function of strut stroke. In the course of the presentation some design rules and cautions are suggested.
Author
Aircraft Landing; Landing Gear; Mathematical Models; Aircraft Tires; Structural Vibration

19960022105 Daimler-Benz Aerospace A.G., Military Aircraft., Munich, Germany
SELF-INDUCED OSCILLATIONS OF LANDING GEAR AS AN INTEGRAL LANDING GEAR AIRCRAFT SYSTEM PROBLEM
Luber, W., Daimler-Benz Aerospace A.G., Germany; Kempf, G., Daimler-Benz Aerospace A.G., Germany; Krauss, A., Daimler-Benz Aerospace A.G., Germany; The Design, Qualification and Maintenance of Vibration-Free Landing Gear; Mar. 1996; 16p; In English; See also 19960022102; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper treats three topics: Two of the topics deal with seemingly self-induced oscillations observed during aircraft and subsystem development tests. The third topic gives a short overview on procedures to treat shimmy as a 'flexible landing gear on flexible aircraft' problem. The topic treated in section 2 (Shimmy on Nose Landing Gear) presents a case observed in taxi tests of a prototype aircraft. Although specific shimmy calculations were not performed for this case, there are indications that a purely lateral/torsional tire model would possibly not have shown the instability observed. Appendix A gives some evidence therefore. Section 3 (Brake Torque Oscillations at Brake Initiation) treats a case where quasi self-induced oscillations are caused by interaction of tyre circumferential force characteristics with the brake control system. Usual means to suppress shimmy (e.g. dampers, modification of landing gear geometry) are ineffective in this case. Landing gear vibrations may cause a variety of problems in the

rest of the aircraft. Section 4 (Integral Landing Gear/Aircraft Problem) presents a summary of potential problem ramifications. It also gives a short overview on a viable approach to treat landing gear shimmy in context with aircraft structure.
Author (revised)
Landing Gear; Oscillations; Shaking; Aircraft Landing; Structural Vibration; Wheel Brakes

19960022106 Pisa Univ., Dipt. di Ingegneria Aerospaziale., Italy
ANALYSIS AND CONTROL OF THE FLEXIBLE DYNAMICS OF LANDING GEAR IN THE PRESENCE OF ANTISKID CONTROL SYSTEMS
Denti, E., Pisa Univ., Italy; Fanteria, D., Pisa Univ., Italy; The Design, Qualification and Maintenance of Vibration-Free Landing Gear; Mar. 1996; 14p; In English; See also 19960022102; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This work is part of research carried out to investigate the vibration problems due to coupling between the flexible dynamics of aircraft landing gear and the dynamics of antiskid control systems. The last objective is the development of new antiskid devices for the suppression of landing gear vibrations during braking. In the paper the above mentioned problems are described together with the models and methods available for their investigation. Preliminary results of the research are also presented. Namely, an analytical and numerical model of the tires in runway contact dynamics, that is one of the most critical models involved, is developed. A linearized model of the system composed of the wheel and the landing gear is developed and the system poles are investigated.
AIAA
Landing Gear; Aircraft Landing; Antiskid Devices; Mathematical Models; Vibration Mode; Wheel Brakes; Landing Loads; Braking

19960022107 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Robotik und Systemdynamik., Wessling, Germany
FUSELAGE VIBRATION CONTROL USING SEMI-ACTIVE FRONT GEAR
Wentscher, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Kortuem, W., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Krueger, W. R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; The Design, Qualification and Maintenance of Vibration-Free Landing Gear; Mar. 1996; 12p; In English; See also 19960022102; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper presents results of research performed in the field of semi-active suspensions for advanced landing gears and optimization of their associated design parameters to achieve minimum weight, maximum comfort under strict requirements with respect to safety and even increase lifetime by reducing the loads during landing impact and taxiing. A detailed mechanical model is derived for an existing aircraft (AIRBUS A300) which will be used for simulating the standard design as well as the active optimized landing gear. The simulation is performed with SIMPACK, DLR's prime multibody computer code. Results will be presented on using the multi-objective parameter optimization software ANDECS. The design case study will concentrate on taxiing of a flexible aircraft. Reduction of the so-called 'beaming effect' (e.g. dynamic coupling of runway excitation with elastic fuselage eigenmodes) is the major design goal.
Author
Fuselages; Vibration Damping; Structural Vibration; Landing Gear; Aircraft Design; Computerized Simulation

19960022108 De Havilland Aircraft Co. of Canada Ltd., Structural Dynamics Group., Downsview, Ontario Canada
LANDING GEAR SHIMMY: DE HAVILLAND'S EXPERIENCE
Glaser, John, De Havilland Aircraft Co. of Canada Ltd., Canada; Hrycko, George, De Havilland Aircraft Co. of Canada Ltd., Canada; The Design, Qualification and Maintenance of Vibration-Free Landing Gear; Mar. 1996; 12p; In English; See also 19960022102; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Landing gear shimmy is an unacceptable situation which, at the very least, leads to increased maintenance costs and at the worst could result in catastrophic failure of the gear and/or the attaching structure. Two landing gear shimmy problems experienced by de Havilland are presented, one in service and the other predicted during design. While these problems occurred over 10 years ago, it is the authors' contention that little progress has been made in this design discipline in the intervening years. It is recommended that advisory material is needed in this important but often neglected subject.
Author
Structural Vibration; Landing Gear; Failure Analysis

19960022109 Daimler-Benz Aerospace A.G., Bremen, Germany
UNSTEADY TIRE DYNAMICS AND THE APPLICATION THEREOF TO SHIMMY AND LANDING LOAD COMPUTATIONS
Koenig, Klaus, Daimler-Benz Aerospace A.G., Germany; The Design, Qualification and Maintenance of Vibration-Free Landing Gear; Mar. 1996; 10p; In English; See also 19960022102; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

A complete set of nonlinear equations of unsteady tire dynamics for all the 6 degrees of freedom of the wheel movement is presented. The coefficients of these equations are based on available publications and may need some improvements. The influence of some of the coefficients which are new or controversely discussed is shown revealing areas of caution and stressing the necessity of adequate tire tests. Nevertheless it could be demonstrated that reasonable shimmy analyses are possible with these equations and that the computation of realistic unsymmetric landing impacts require their inclusion as a must.
Author
Aircraft Tires; Structural Vibration; Landing Loads; Aircraft Landing

19960022110 Messier-Dowty S.A., Velizy, France
INFLUENCE OF NONLINEARITY ON THE SHIMMY BEHAVIOUR OF LANDING GEAR
Woerner, P., Messier-Dowty S.A., France; Noel, O., Messier-Dowty S.A., France; The Design, Qualification and Maintenance of Vibration-Free Landing Gear; Mar. 1996; 12p; In English; See also 19960022102; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

One of the most critical vibratory phenomena which may occur on a landing gear is called 'shimmy'. It is typically unstable oscillations that could reach such a level of instability that major landing gear structural components may be damaged or destroyed. For many years, Messier-Dowty S.A. has studied this phenomenon in order to perform more accurate predictions of the dynamic behaviour of landing gear. Several models have been developed taking into account many parameters, and especially the non-linear ones, in agreement with test measurements. Simulations have been performed, which show the sensitivity of shimmy stability to variations of these parameters, and therefore the importance of taking account non-linearities in shimmy landing gear models.
Author
Landing Gear; Dynamic Characteristics; Structural Vibration; Nonlinearity; Dynamic Structural Analysis; Vibration Mode

19960022111 McDonnell-Douglas Aerospace, Structural Dynamics and Loads Div., Saint Louis, MO United States
A NONLINEAR MODEL FOR LANDING GEAR SHIMMY WITH APPLICATIONS TO THE MCDONNELL DOUGLAS F/A-18A
Baumann, Jeff, McDonnell-Douglas Aerospace, USA; The Design, Qualification and Maintenance of Vibration-Free Landing Gear; Mar. 1996; 12p; In English; See also 19960022102; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper discusses a nonlinear shimmy model that includes components and features typically found in the nose landing gear of fighter aircraft. The gear structural model includes inertia, coulomb and viscous damping, stiffness, and torsional freeplay. Single and dual non-corotating wheels are considered. The tires are represented with the Moreland point-contact tire model. Qualitative analytical results from modeling the nose landing gear of the McDonnell Douglas F/A-18A are presented. This landing gear, in the normal US Navy carrier-based configuration, is stable. When the launch bar and its power unit are removed for land-based versions of the aircraft, the nose gear may, under certain adverse conditions, experience shimmy. This condition can be aggravated by rotating forces due to tire unbalance or other irregularities. A number of corrective modification have been attempted with varying degrees of success. These range from relatively simple measures, such as increasing attention to tire maintenance, to more complicated schemes, such as adding a friction collar, adding mass dampers or even adding a dummy launch bar. For the

most severe cases, the dummy launch bar seems to be required, however, the friction collar with mass dampers does show a significant improvement.
Author
Vibration Damping; Landing Gear; Nonlinearity; Mathematical Models; Dynamic Structural Analysis; Structural Vibration

19960022326 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
AERODYNAMICS OF STORE INTEGRATION AND SEPARATION ***L'AERODYNAMIQUE DE L'INTEGRATION ET DU LARGAGE DES CHARGES EXTERNES***
Feb. 1996; 274p; In English; In French; 76th Fluid Dynamics Panel Symposium, 24-27 Apr. 1995, Ankara, Turkey; See also 19960022327 through 19960022348; Original contains color illustrations
Report No.(s): AGARD-CP-570; ISBN 92-836-0022-3; Copyright Waived; Avail: CASI; A12, Hardcopy; A03, Microfiche

The papers prepared for the AGARD Fluid Dynamics Panel (FDP) Symposium on 'Aerodynamics of Store Integration and Separation', which was held 24-27 April 1995 in Ankara, Turkey are contained in this report. In addition, a Technical Evaluator's Report aimed at assessing the success of the symposium in meeting its objectives, and an edited transcript of the General Discussion held at the end of the symposium are also included. The aim of this symposium was to bring together engineers in the fields of theoretical and experimental aerodynamics, as applied to the store integration problem, to review and discuss the state of the art in the prediction, methodology and experimental techniques currently being developed and applied to the aerodynamics of store carriage and release and to assess new design concepts.
Author
Aerodynamics; Conferences; External Stores; Prediction Analysis Techniques; Design Analysis; External Store Separation

19960022327 Daimler-Benz Aerospace A.G., Military Aircraft Div., Munich, Germany
STRATEGIES FOR MODELLING AERODYNAMIC INTERFERENCE DURING STORE SEPARATION
Deslandes, R., Daimler-Benz Aerospace A.G., Germany; Feb. 1996; 12p; In English; See also 19960022326; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

All contributions dealing with the modelling of aerodynamic interference of store separation can be catalogued according to their strategies. In the following it will be shown that the great number of available solutions can be reduced to only two categories denominated here Pseudo-Unsteady and Unsteady Strategies. Pseudo-Unsteady Strategies are the most common solutions applied to industrial projects. The three powerful variants are identified as Decay Factorization, Flow Angularity and Iterative Techniques. This last subcategory provides the link between pseudo- and real-unsteady approaches, which are divided into two main groups of strategies, assigned to Global Solutions and Grid-Overlapping Techniques. In addition to this catalogue, the common computational fluid dynamical tools of store separation are outlined respective to their physical relevance and their numerical complexity. Finally an example based on consideration of three strategies, in use at Daimler-Benz Aerospace AG (DASA) will be demonstrated.
Author
Aerodynamic Interference; External Store Separation; Computer Programs; Prediction Analysis Techniques; Computational Fluid Dynamics; Fighter Aircraft

19960022329 Aerospatiale Missiles, Verrieres-le-Buisson, France
A NEW CHIMERA METHOD FOR CALCULATING MISSILES IN RELEASE POSITION ***UNE NOUVELLE METHODE CHIMERE POUR LE CALCUL DE MISSILES EN POSITION D'EMPORT***
Gillyboeuf, J.-P., Aerospatiale Missiles, France; Feb. 1996; 12p; In French; See also 19960022326; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The principle of the local incidence methods used by Aerospatiale Missiles for the studies of 'letting go' is presented. Their limits are accordingly evidenced. For this reason, they are completed by numerical simulation, based on solving Euler equations, of the flow around the aerodynamic missile configuration. The principle difficulty in calculations of this type is creating the computational grids. The Chimera approach is used for modeling. The principle of the first method that will be developed here, called the Chimera Method by Recovery (MCR -- french acronym), is recalled. It widely inspired those used by Benek et al.. It is used for simulating the ASMP missile release under a Mirage 2000. However, the problems become apparent when the missile is in position to take-off, where it is very close to the aircraft. This is why a new method, called Chimera Method by Truncation (MCT) is developed. Its principle is exposed, with care to distinguish it from MCR. It equally has inconveniences. A third method, called Chimera Mixed Method (MCM), is created. It blends the MCR and the MCT, the combination preserving the advantages of each method. The MCT is validated in a 2D case. The study of a 3D configuration, which can represent a missile in release position, shows that the MCM gives much better results than those obtained with MCR.
Transl. by CASI
Missiles; Computational Fluid Dynamics; External Store Separation; Launching; Differential Equations; Numerical Flow Visualization

19960022330 MATRA Defense Espace, Velizy-Villacoublay, France
METHODS FOR PREDICTING THE SEPARATION OF STORES: STATE OF THE ART USING MATRA DEFENSE ***METHODES POUR LA PREDICTION DES SEPARATIONS DE CHARGES: ETAT DE L'ART A MATRA DEFENSE***
Jeune, C., MATRA Defense Espace, France; Mansuy, P., MATRA Defense Espace, France; Dumas, E. Ribadeau, MATRA Defense Espace, France; Bredif, M., MATRA Defense Espace, France; Feb. 1996; 18p; In French; See also 19960022326; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Ejection as a firing mode for new missiles developed by Matra Defense created a need for new developments in the simulation of the store aerodynamic behavior during the separation phase. We present here four methods used in the separation predictions, on one hand methods based on an experimental approach in wind tunnel: captive trajectories and grids, and on the other hand computational methods: 'local flow incidence' method and Chimera method.
Author
External Store Separation; Ejection; Missiles; Aerodynamic Characteristics; Prediction Analysis Techniques; Numerical Flow Visualization

19960022331 Defence Research Agency, Farnborough, Low Speed and Basic Aerodynamics Dept., Hampshire, United Kingdom
THEORETICAL PREDICTION OF STORE RELEASE TRAJECTORY USING THE FAME METHOD
Blaylock, T. A., Defence Research Agency, Farnborough, UK; Feb. 1996; 10p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A method is described for generating surface and field meshes around complex configurations. The method, known as FAME (Feature-Associated Mesh Embedding) combines a high degree of automation and ease of use with precise control over mesh quality. The extension of the method to deal with configurations with components in relative motion is described. Euler flow results, at a transonic Mach number and at two different angles of incidence, are presented for a store released from a cluster of three beneath a wing.
Author
External Store Separation; Computational Grids; Grid Generation (Mathematics); Computational Fluid Dynamics

19960022334 British Aerospace Public Ltd. Co., Aerodynamics and Vulnerability Research Dept., Bristol, United Kingdom
DEVELOPMENT OF NUFA AND ITS APPLICATION WITHIN A HYBRID STORE LOAD PREDICTION METHOD
McDougall, S., British Aerospace Public Ltd. Co., UK; Press, A. J., British Aerospace Public Ltd. Co., UK; Feb. 1996; 20p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The NUFA semi-empirical prediction program was originally developed to estimate the aerodynamic loads experienced by configurations immersed in a non-uniform flowfield such as those found in close proximity to a parent aircraft. The code is used throughout BAe Defence Ltd. for the prediction of isolated weapon aerodynamic loads and the determination of carriage/trajectory characteristics both in a stand-alone mode and integrated into trajectory calculation suites. A recent new release of the program incorporates a number of develop-

ments aimed at extending the range of configurations which can be modelled, improving the accuracy of existing calculation techniques and improving the user/program interface. Additionally, development work is currently being carried out to enable the modelling of stores with bodies of arbitrary cross-section with the aim of allowing the program to estimate the loads experienced on modern configurations developed for improved low observability and submunition dispensing purposes. An outline description of the new capabilities which have been incorporated into the current release version of the program and those which are still undergoing development is given within this paper. The code has undergone extensive validation studies for the estimation of free-air store characteristics and the determination of carriage/grid loads within a hybrid load prediction scheme. The hybrid scheme requires the flowfield in which the store is immersed to be input to NUFA. The flexibility of the scheme is such that the flowfield may be obtained from any source, either experiment or theoretical method. Examples of the use of the hybrid scheme are presented, demonstrating the flexibility, relatively low cost and ease of use of the technique.
Author
Prediction Analysis Techniques; Aerodynamic Loads; External Stores; Computational Grids; Flow Distribution; Aerodynamic Configurations; Computational Fluid Dynamics

19960022335 Nielsen Engineering and Research, Inc., Mountain View, CA United States
ENGINEERING-LEVEL METHODS FOR CARRIAGE LOADS, HIGH ALPHA LAUNCH FROM PITCHING AIRCRAFT, AND SUBMUNITION AERODYNAMICS
Dillenius, Marnix F. E., Nielsen Engineering and Research, Inc., USA; Perkins, Stanley C., Jr., Nielsen Engineering and Research, Inc., USA; Lesieutre, Daniel J., Nielsen Engineering and Research, Inc., USA; Feb. 1996; 10p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Recent applications are presented of engineering-level methods to describe or predict store carriage and separation problems. The examples described in this paper are concerned with estimating aerodynamic load acting on the tail fins of a wing-tip mounted missile, predicting trajectory characteristics of a stable and a less stable missile rail-launched from a pitching aircraft at high angle of attack, and predicting aerodynamic aspec of submunitions in the vicinity of a dispenser. In most cases, comparisons with experimental data are shown. The engineering-level approaches are capable of handling parametric studies involving store component loads and store separation from a maneuvering aircraft and the methodology can predict submunition aerodynamics quickly. The particular store separation problems described herein are not easily accomplished with the more accurate CFD approaches especially for cases involving maneuvering parent aircraft.
Author
Aerodynamic Loads; External Store Separation; Missiles; Prediction Analysis Techniques; Nonlinearity

19960022336 Nielsen Engineering and Research, Inc., Mountain View, CA United States
CARRIAGE AND RELEASE AERODYNAMICS OF THE PEGASUS (R) AIR-LAUNCHED SPACE BOOSTER
Mendenhall, Michael R., Nielsen Engineering and Research, Inc., USA; Lesieutre, Teresa O., Nielsen Engineering and Research, Inc., USA; Lesieutre, Daniel J., Nielsen Engineering and Research, Inc., USA; Dillenius, Marnix F. E., Nielsen Engineering and Research, Inc., USA; Feb. 1996; 12p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Pegasus(R), the air-launched space booster designed for launch from B-52 and L-1011 aircraft, was developed using computational aerodynamic methods without benefit of specific wind tunnel or flight testing. This paper describes the methods and procedures used for predicting the carriage and launch characteristics of Pegasus from both B-52 and L-1011 aircraft. Flight data from four B-52 launches and a single L-1011 launch are available to validate the prediction methods.
Author
Pegasus Air-Launched Booster; Prediction Analysis Techniques; Air Launching; Aerodynamic Characteristics; Missile Trajectories

19960022337 Pisa Univ., Dept. of Aerospace Engineering., Italy
USE OF A CAPTIVE TRAJECTORY SYSTEM IN A WIND TUNNEL
Lombardi, G., Pisa Univ., Italy; Johnston, C. M., Council for Scientific and Industrial Research, South Africa; Feb. 1996; 10p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The capabilities of a six degree of freedom Captive Trajectory System (CTS) in a transonic wind tunnel are investigated, and some aspects related to its operation are singled out. The two operative modes ('position' mode and 'velocity' mode) and the repeatability of the data under those conditions expected to be critical are analyzed. The capabilities of the facility, are studied by means of a test campaign with a typical interference geometry, composed of a store and a wing-fuselage aircraft. The results obtained show that the CTS technique can simulate the effect of the various parameters affecting the trajectory of a released store, within the usual limitations of a wind tunnel simulation. With the CTS technique, the analysis of several different parameters proved easy and fast to carry out. Furthermore, a 'grid test' performed on the same configuration underlined the importance of this application of the CTS for a better understanding of the aerodynamic behaviour of the interfering bodies, which appears to be an essential feature for correctly defining safe and efficient conditions for store release.
Author
Wind Tunnel Tests; External Store Separation; Aerodynamic Interference; Trajectories; Transonic Wind Tunnels

19960022338 Office National d'Etudes et de Recherches Aerospatiales, Centre d'Essais de Modane-Avrieux., Modane, France
NEW CAPTIVE TRAJECTORY SYSTEM FOR THE LARGE SUBSONIC S1MA WIND TUNNEL OF ONERA *NOUVEAU SYSTEME DE TRAJECTOGRAPHIE CAPTIVE POUR LA GRANDE SOUFFLERIE SONIQUE S1MA DE L'ONERA*
Raffin, J. C., Office National d'Etudes et de Recherches Aerospatiales, France; Remandet, J. N., Office National d'Etudes et de Recherches Aerospatiales, France; Rondeau, D., Dassault Aviation, France; Aerodynamics of Store Integration and Separation; Feb. 1996; 16p; In French; See also 19960022326; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

ONERA, the French National Establishment for Aerospace Research has just implemented at the large subsonic S1MA windtunnel a Captive Trajectory System (CTS) which is one of the most important devices of this type in the world. STPA, the Technical Department for Aeronautical Program of the French Ministry of Defense has funded an important part of the study and manufacture of this new device. This device and the first test results wind-on are presented here.
Author
External Store Separation; Wind Tunnel Tests; Subsonic Wind Tunnels; Trajectories; Aerodynamic Characteristics

19960022339 British Aerospace Public Ltd., Co., Military Aircraft Div., North Humberside, United Kingdom
EXPERIMENTAL TECHNIQUES FOR MODELLING STORE CARRIAGE AND RELEASE AT SMALL SCALES
Bettridge, V. H. A., British Aerospace Public Ltd., Co., UK; Feb. 1996; 14p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper will discuss wind-tunnel testing aspects of store trajectory modelling and store carriage load evaluation, at small scale, in the British Aerospace, Military Aircraft Division,(M.A.D.) windtunnel facilities. There is discussion of the enhancements, developed within the department, of the 'light model' scaling technique for free store wind-tunnel releases, and of the recent re-appraisal of strain gauge balance design philosophy and the use of newer concepts in strain measurement in small, stiff, balance structures, which is building on our expertise in this field.
Author
External Store Separation; Wind Tunnel Tests; Scale Models; Wind Tunnel Models; Strain Gage Balances

19960022340 National Research Council of Canada, Inst. for Aerospace Research., Ottawa, Ontario Canada
F18 EXTERNAL STORES GRID MEASUREMENT TESTING IN THE IAR/NRC 1.5M BLOWDOWN WIND TUNNEL
Thain, James A., National Research Council of Canada, Canada;

Lafrance, Robert, National Defence Headquarters, Canada; Feb. 1996; 10p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A Canadian Forces stores separation prediction capability was initiated in the late 1970s with the development of a store separation computer model supported by wind tunnel measurements. The separation of an external store from an aircraft is a complex event requiring, among other items, a detailed knowledge of the influence of the aircraft flowfield upon the store. The grid survey method, which is essentially a flowfield mapping technique, offers an accurate method for acquiring aerodynamic interference coefficients which are input to the store separation model. However, due to small model scales used for grid survey measurements, additional larger scale wind tunnel investigations are often necessary in order to ensure a faithful reproduction of the store model.

Author

Wind Tunnel Tests; External Stores; Aerodynamic Interference; External Store Separation; Flow Distribution; Wind Tunnel Models

19960022341 Bombardier, Inc., Dorval, Quebec Canada

ESTIMATION OF STORE INTERFERENCE LOADS USING TRANSONIC SMALL DISTURBANCE THEORY AND INFLUENCE FUNCTION METHOD

Piperni, P., Bombardier, Inc., Canada; Stokoe, K., Bombardier, Inc., Canada; Feb. 1996; 12p; In English; See also 19960022326; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper presents a method for predicting aerodynamic interference loads on stores which are ejected or launched from the CF-18 aircraft at transonic flight conditions. A transonic small disturbance theory and an influence function method were employed to estimate interference loads. Predictions for the AIM-7 sparrow missile in the presence of a 330 gallon fuel tank on the aircraft centerline and 980 gallon fuel tanks on the inboard wing pylons are compared with wind tunnel test results. Corrections for sting effects are also included.

Author

Aerodynamic Interference; Aerodynamic Loads; External Stores; Transonic Flight; Flow Distribution; Applications Programs (Computers)

19960022342 British Aerospace Defence Ltd., Military Aircraft Div., Warton, United Kingdom

FLIGHT TEST TECHNIQUES FOR WEAPON/STORE RELEASE TRAJECTORY ANALYSIS

Donaldson, T., British Aerospace Defence Ltd., UK; Gill, A. D., British Aerospace Defence Ltd., UK; Feb. 1996; 8p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The use of store trajectory prediction techniques is an integral part of a stores release clearance program. In support of these prediction techniques, it is necessary to produce a highly accurate measured trajectory from the flight trial demonstrations. The procedure used at Warton is based on a mathematical model and a fly - match - fly progression and this paper identifies the techniques used by British Aerospace Warton to calculate the store release trajectories. It identifies the store trajectory analysis system that is currently in use and the system enhancements, which includes an automatic tracking facility, that are being introduced. The aim of the system upgrade is to produce more accurate trajectories in reduced timescales and hence reduce the number of flights and store releases required. This will lead on to a reduction in costs and shorter trials programs. The paper also identifies future system enhancements that can be introduced that may lead to the advent of real time store trajectory analysis.

Author

Weapon Systems; External Store Separation; Flight Tests; Trajectory Analysis; Prediction Analysis Techniques; Upgrading

19960022346 British Aerospace Defence Ltd., Military Aircraft Div., Warton, United Kingdom

THE IMPLICATIONS OF STORES CARRIAGE AND RELEASE FOR AIRCRAFT FLIGHT CONTROL SYSTEM DESIGN

Allen, D. A., British Aerospace Defence Ltd., UK; Hulme, K. F., British Aerospace Defence Ltd., UK; Feb. 1996; 12p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Against a backdrop of a review of the capabilities and limitations of a modern digital aircraft flight control system, this paper considers the implications of the carriage and release of a wide range of stores for modern high performance military aircraft. At the heart of any flight control system design is consideration of the characteristics of the vehicle and its operating environment. It is in consideration of these aspects that the major impact of external (and internal) stores carriage and release occurs. The relevant vehicle characteristics are described by its aerodynamic, inertial, and structural properties which are all complex in their own right but are also substantially affected by stores carriage. Releasing stores from the vehicle will excite both rigid body and flexible modes of the vehicle due to rapidly changing the vehicle's mass, inertial and aerodynamic characteristics. Despite the rapid technological advances in flight control system design, the underlying physical limits remain, and will continue to do so! A clear recognition of these limitations and their implications is essential, particularly at the concept and early design stages of a project. This paper addresses the major issues involved and the interaction between stores integration and flight control system design for modern fighter aircraft.

Author

External Stores; External Store Separation; Aircraft Control; Control Systems Design; Flight Control; Aerodynamic Interference

19960023118 GEC-Marconi Avionics Ltd., Rochester, United Kingdom

DEVELOPMENT AND EVALUATION OF THE AH-1W SUPERCOCKPIT

Puleston, D. J., GEC-Marconi Avionics Ltd., UK; Holley, C. D., Textron Bell Helicopter, USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 10-1 - 10-4; In English; See also 19960023107; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

An extensively modified AH-1W SuperCobra has been proposed for the British Army's new attack helicopter. Called Venom, the aircraft features an advanced technology mission equipment package integrated at the human/ machine level by the AH-1W SuperCockpit(TM). This cockpi provides one of the world's most capable and integrated attack helicopter crew-stations, incorporating the latest techniques in 'glass cockpit' design with key design objectives being to reduce crew workload, enhance mission effectiveness and maximize situational awareness.

Author

Helicopters; Cockpits; Crew Workstations

19960026141 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France

GLASS COCKPIT OPERATIONAL EFFECTIVENESS *L'EFFICACITE OPERATIONNELLE DU POSTE DE PILOTAGE EN VERRE*

Apr. 1996; 192p; In English; Original contains color illustrations

Report No.(s): AGARD-AR-349; ISBN 92-836-1034-2; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

The members of AGARD FMP Working Group 21, representing aircraft manufacturers, research institutions and operational organizations, met over a two year period, 1993-1995 to address the following objective: Summarize the status of current cockpits, highlight their benefits and weaknesses, and provide guidance for future cockpit design. This report, the result of those meetings, is structured around the series of questions listed below: (1) What are the pilot and crew required to do to complete a mission successfully; (2a) What do the current glass cockpits consist of; (2b) What are some of the technological highlights and trends of these cockpits; (3) What new technologies are becoming available; (4) How can we tailor the cockpit to be the most suitable for the human operator; (5) How can and how does the use of glass cockpits change the required aircrew training process; (6) What are the key problem issues with the current design process and what suggestions can be made to improve it and; (7) What are the cockpit concepts being considered to improve the operational effectiveness of future aircraft. With consideration of the human factors issues in design as a major basis for this report, this document provides an in depth discussion of the cockpit of today's aircraft and can serve as a foundation upon which to develop a more optimized pilot-vehicle-system interface of tomorrow.

Author

Fighter Aircraft; Helicopters; Cockpits; Human Factors Engineering; Man Machine Systems

19960033256 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
INTEGRATED VEHICLE MANAGEMENT SYSTEMS
Apr. 1996; 144p; In English
Report No.(s): AGARD-AR-343; ISBN 92-836-1035-0; Copyright Waived; Avail: CASI; A07, Hardcopy; A02, Microfiche

Major trends in technology, weapon system performance goals and affordability for aerospace systems are occurring simultaneously. For avionic systems this performance and affordability can be achieved by functional and physical integration. 'Functionally' integrated subsystems to achieve higher performance has been greatly aided by advances in computer technology. The desire to minimize costs for these systems has been accomplished through a 'physical' integration concept based upon common modules tied through a high speed backplane. The concept, called integrated avionics, has been used on new aircraft such as the US Air Force F-22 fighter and the Boeing 777 commercial transport. Vehicle management systems provide the management of crucial flight functions and systems for advanced aerospace vehicles. These systems must have high integrity, safety, and overall fault tolerance. Low cost modular avionics are unproven for such fault tolerant systems. This becomes a key issue for investigation. This report deals with the key problems in fault tolerance for modular computer based systems. New techniques, only recently applied, provide exciting possibilities to reduce avionics costs and maintain high integrity and safety. These techniques and more are discussed in this report sponsored by the Mission Systems Panel of the AGARD.
Author
Fault Tolerance; Functional Integration; Avionics; Cost Reduction; Modularity; Aircraft Design; Flight Control; Computer Aided Design; Systems Health Monitoring

19960052861 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
EVALUATION OF LOADS FROM OPERATIONAL FLIGHT MANEUVERS
Apr. 1996; 124p; In English
Report No.(s): AGARD-AR-340; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

This AGARD Advisory Report describes an evaluation of a method to derive loads from operational flight maneuvers. The basic assumption of this method is that all operational maneuvers performed in service can be verified as a set of Standard Maneuvers (normalized parameter time histories for each independent maneuver type). The verification of Standard Maneuvers is based on recordings of relevant maneuver parameters in service and for new tactics/missions on special flights or simulations. The initial evaluation of the concept done by the Working Group (WG.27) has demonstrated the feasibility of determining loads from operational flight maneuvers.
Author
Aircraft Maneuvers; F-16 Aircraft; Load Distribution (Forces); F-18 Aircraft; Flight Tests

19960053195 National Research Council of Canada, Inst. for Aerospace Research, Ottawa, Ontario Canada
THE COMPUTATION OF AIRCRAFT STORE TRAJECTORIES USING HYBRID (STRUCTURED/UNSTRUCTURED) GRIDS
Jones, D. J., National Research Council of Canada, Canada; Fortin, F., National Research Council of Canada, Canada; Hawken, D., National Research Council of Canada, Canada; Syms, G. F., National Research Council of Canada, Canada; Sun, Y., National Research Council of Canada, Canada; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

With the high costs associated with flight and wind tunnel testing, the computation of aircraft store trajectories is becoming more important to the military establishment. In Canada, the Department of National Defense (DND) requested IAR to acquire/develop the necessary tools to carry out the prediction of stores on release from aircraft - particularly the DND's CF-18 aircraft. After debating whether to use structured Chimera schemes or unstructured schemes, IAR decided to use the latter techniques as there was already a development program in that field of research. IAR had already demonstrated that hybrid (structured/unstructured) grids had produced successful results and decided to pursue this approach for the unsteady 3D computations. to this end, a study was made in the 2D case of a 'store' moving from the parent 'body'. Grid generation is underway for the full CF-18 aircraft using a commercial code and several simpler cases have been gridded and computations made in a steady 3D environment.
Author
Grid Generation (Mathematics); Computational Grids; Computational Fluid Dynamics; F-18 Aircraft; Trajectory Analysis; Ordnance; Computerized Simulation

19960054454 Eurofighter Jagdflugzeug G.m.b.H., Hallbergmoos, Germany
PROPULSION INTEGRATION ASPECTS IN ADVANCED MILITARY AIRCRAFT
Hienz, E., Eurofighter Jagdflugzeug G.m.b.H., Germany; Illuzzi, L., Eurofighter Jagdflugzeug G.m.b.H., Germany; Herrmann, P., Eurojet Turbo G.m.b.H., Germany; Advanced Aero-Engine Concepts and Controls; Jun. 1996; 18p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Historically, airframe/engine integration was mainly related to physical aspects requiring only a low degree of sophistication. With the advent of more overall system performance consciousness, propulsion integration has become a major task split between airframe and engine engineers. It now includes performance, functional and physical aspects all needing to be integrated to meet specific requirements. Aircraft and engine configurations are therefore optimized simultaneously at a very early stage of development. Some of the major interfaces influencing configuration, performance, and operability are discussed, i.e., intake/engine/afterbody; and electronic controls integration (including monitoring); performance optimization, systems, and installation.
Author
Aircraft Engines; Engine Airframe Integration; Propulsion System Configurations; Control Systems Design; Systems Integration; Inlet Airframe Configurations

19970000608 Defence Research Agency, Flight Dynamics and Simulation Dept., Bedford, United Kingdom
UK ATTACK HELICOPTER FLYING QUALITIES: THE ROLE OF PILOTED SIMULATION EVALUATION IN SUPPORTING THE PROCUREMENT DECISION MAKING PROCESS
Charlton, M. T., Defence Research Agency, UK; Padfield, G. D., Defence Research Agency, UK; Green, J. T., Ministry of Defence, UK; Apr. 1996; 20p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Contenders for the UK Army's Attack Helicopter (AH) competition, were subjected to a Technical Assessment during the period November 1993 to December 1994. The Defence Research Agency's Flight Dynamics and Simulation Department were Lead Assessors for the flight control system and handling qualities aspects of the assessments. FDS carried out a program of off-line and piloted simulation activities in support of the handling qualities assessments, using the DRA's HELISIM simulation model. A piloted simulation evaluation was completed using the DRA's Advanced Flight Simulator, where the objective was to evaluate the contenders handling qualities and agility in the context of the AH mission. The paper describes the test techniques and procedures used in the tests and discusses the background details of the handling qualities assessment methodology. Some conclusions are also drawn regarding the effectiveness of simulation in supporting defence procurement objectives, and potential future developments.
Author
Helicopters; Competition; Decision Making

19970000609 NASA Ames Research Center, Moffett Field, CA United States
THE USE OF PILOTED SIMULATION FOR CIVIL TILTROTOR INTEGRATED COCKPIT DESIGN
Decker, William A., NASA Ames Research Center, USA; Simmons, Rickey C., NASA Ames Research Center, USA; Tucker, George E., NASA Ames Research Center, USA; Apr. 1996; 24p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Ground-based flight simulators are receiving increased use in the design of civil aircraft. In addition to traditional simulation roles in support of cockpit control and display design, simulators are now used

to develop new flight procedures and to assist in airport design. This is particularly true for the concept of a civil tiltrotor transport. This presentation summarizes recent simulation activity at NASA's Ames Research Center focused on the design requirements for the introduction of tiltrotor aircraft as economic vertical flight transports.
Author
Vertical Flight; Flight Simulators; Economics; Display Devices; Cockpits; Tilt Wing Aircraft

19970000610 Boeing Defense and Space Group, Helicopters Div., Philadelphia, PA United States
SIMULATION APPLICATIONS IN V-22 AND RAH-66 DESIGN AND DEVELOPMENT
Sheffield, R. E., Boeing Defense and Space Group, USA; Lalicker, L. E., Boeing Defense and Space Group, USA; Apr. 1996; 6p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Boeing Company Defense & Space Group, Helicopters Division, has increasingly applied constructive and virtual simulation in support of its aircraft developmental programs which include the V-22 Osprey and the RAH-66 Comanche. From their conceptual phases to present, methodologies and mission simulation capabilities have evolved rapidly due to tremendous advances in computing power. by interacting directly with the systems engineering process, simulation has proven to be extremely valuable in optimizing rotorcraft survivability and mission effectiveness. At the same time, simulation has proven to be an effective means of reducing risk and costly flight testing. Recent focus has been on evolving our simulation capabilities for participation in Distributive Interactive Simulation (DIS). These capabilities and their acquired techniques provide potential opportunities to (1) better apply simulation to increase operational effectiveness of future rotorcraft, and (2) facilitate customer involvement in the developmental process.
Author
V-22 Aircraft; Computerized Simulation; Rotary Wing Aircraft; System Effectiveness

19970000611 Eurocopter France, Marignane, France
PILOTED SIMULATION IN ROTORCRAFT DESIGN AND DEVELOPMENT: EUROCOPTER EXPERIENCE AND FUTURE TRENDS
LA SIMULATION PILOTEE POUR LA CONCEPTION ET LE DEVELOPPEMENT DES APPAREILS A VOILURE TOURNANTES: L'EXPERIENCE D'EUROCOPTER ET LES TENDANCES POUR LE FUTUR
Rollet, Philippe, Eurocopter France, France; Apr. 1996; 10p; In French; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Piloted simulation has largely been used in EUROCOPTER's developments for the last 10 years. For the TIGER attack helicopter, piloted simulation was extensively used from the very beginning of the development to the prototypes' nights. Today, the development of the NH-90 helicopter requires a lot of experimentations on the SPHERE simulator. Piloted simulation is also used for research related to handling qualities, such as the ACT European program, or to Man-Machine-Interfaces (MMI's). The implementation of demonstrators, such as the FBW DAUPHIN, as well as the study of the EUROFAR Tilt-Rotor have also largely involved piloted simulations. A significant experience in testing procedures has been acquired. Environmental and human factors appear to be of the greatest importance. In the future, evolutions are planned to further enhance the representativity of SPHERE simulator. The emergence of new design standards, such as ADS-33C, leads to envisage new applications of piloted simulation.
Author
Tilt Rotor Aircraft; Rotary Wing Aircraft; Man Machine Systems; Human Factors Engineering; Military Helicopters

19970000621 NASA Ames Research Center, Moffett Field, CA United States
RESEARCH APPLICATIONS AND CAPABILITIES OF THE NASA/ARMY ROTORCRAFT AIRCREW SYSTEMS CONCEPTS AIRBORNE LABORATORY (RASCAL)
Aiken, Edwin W., NASA Ames Research Center, USA; Jacobsen, Robert A., NASA Ames Research Center, USA; Hindson, William S., NASA Ames Research Center, USA; Apr. 1996; 14p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Rotorcraft Aircrew Systems Concepts Airborne Laboratory (RASCAL) is a UH-60 Black Hawk helicopter that is being modified by NASA and the US Army for flight systems research. The principal systems that are being installed in the aircraft are a Helmet-Mounted Display (HMD) and associated imaging systems, and a programmable full-authority Research Flight Control System (RFCS). In addition, comprehensive instrumentation of both the rigid body of the helicopter and the rotor system is provided. This paper describes the design features of this modern rotorcraft in-flight simulation facility and their current state of development. A brief description of initial research applications is included.
Author
Rotary Wing Aircraft; Flight Control; Flight Crews; Helicopter Design; Helmet Mounted Displays; Flight Simulation

19970001702 Daimler-Benz Aerospace A.G., Military Aircraft, Munich, Germany
FUNDAMENTALS ON DAMAGE MONITORING
Boller, Christian, Daimler-Benz Aerospace A.G., Germany; Oct. 1996; 16p; In English; See also 19970001697; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Within the paper, the following is discussed: existing load monitoring systems in aircraft and their use for fatigue damage evaluation; validation of different NDT-techniques with regard to their use for and integration into composite materials; validation of the use of structural health (damage) monitoring systems; parameters and techniques based on piezoelectric sensing for monitoring impact loads. It is concluded that structural health monitoring can have a beneficial effect in combination with composite materials.
Author
Damage Assessment; Detection; Fatigue (Materials); Aircraft Structures; Impact Loads

19970001707 Northrop Grumman Corp., Military Aircraft Systems Div., El Segundo, CA United States
STRUCTURAL HEALTH MONITORING OF AIRCRAFT COMPONENTS
Kudva, Jayanth N., Northrop Grumman Corp., USA; Lockyer, Allen J., Northrop Grumman Corp., USA; VanWay, Craig B., Northrop Grumman Corp., USA; Oct. 1996; 6p; In English; See also 19970001697
Contract(s)/Grant(s): F33615-92-C-3203; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Since the late fifties when fatigue problems in aircraft structures were first encountered, aircraft maintenance has evolved through research, and subsequent implementation in well-orchestrated programs in several NATO countries. In the USA Air Force, the Aircraft Structural Integrity Program (ASIP), and similar programs in other US service organizations, deserve much of the credit for establishing a first class record for US fleet readiness. ASIP's success, similar to other NATO programs, rely heavily (still) on frequent aircraft inspections to ensure fatigue cracking, or other flaws, get the necessary attention, and appropriate corrective action, before vehicle safety is compromised. Recent initiatives at Northrop Grumman, together with research elsewhere in structural health monitoring systems (SHMS), now point one step further toward improved safety and maintenance costs reductions. Though not yet mature, recent technological advances in sensors, data acquisition, electronic miniaturization, and sensor system integration, now make it conceivable, at least, to replace current scheduled driven inspection practices - prevalent in aerospace systems maintenance throughout NATO- with 'maintenance-on-demand.' Put simply, aircraft structural inspections and maintenance will be performed only when really necessary and there is a high probability of finding damage, rather than scheduled, when often there is no damage detected. An overview of ASIP is first introduced as background to the subject of structural health monitoring in the US reviewing inspection requirements, critical flaw sizes, and operational load environments. SHMS technologies are subsequently reviewed featuring requirements, architectures and components, sensors, processors, analysis algorithms and software, and SHMS component technology status. Finally, conclusions and recommendations for technology transition and future work are reported.
Author
Aircraft Structures; Aircraft Maintenance; Aerospace Systems; Defects; Health

19970001708 Northrop Grumman Corp., Military Aircraft Systems Div., El Segundo, CA United States
ADAPTIVE AIRCRAFT WING
Kudva, Jayanth N., Northrop Grumman Corp., USA; Lockyer, Allen J., Northrop Grumman Corp., USA; Appa, Kari, Northrop Grumman Corp., USA; Oct. 1996; 6p; In English; See also 19970001697; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The concept of an adaptive aircraft wing, i.e., whose shape parameters such as camber, span-wise twist, and thickness can be varied to optimize the wing shape for various flight conditions, has been extensively studied by numerous researchers. While the aerodynamic benefits (in terms of increased lift/drag ratios, improved maneuverability, and delayed flow separation) have been analytically and experimentally established, the complexity and weight penalty of the designs and actuation mechanisms have limited their practical implementation. Recent developments in sensors and actuators using smart materials could potentially alleviate the shortcomings of prior designs, leading the way to a more practical 'smart' adaptive wing which responds to changes in flight and environmental conditions by optimally modifying its shape. A summary of recent work in the area of adaptive wing concepts incorporating smart structures technologies i s presented. Emphasis is placed on continuing research at Northrop Grumman under a USA Defense Advanced Research Projects Agency (DARPA) contract entitled 'Smart Structures and Materials Development-Smart Wing.' Limitations and potential benefits of adaptive wing designs, applications and advantages of smart material actuators and sensors, and results of recent tests are discussed. Recommendations for future work required to develop an operational smart adaptive wing are also outlined.
Author
Smart Structures; Camber; Lift Drag Ratio; Maneuverability; Cambered Wings

19970009256 NASA Lewis Research Center, Cleveland, OH United States
COMPUTATIONAL MODELING AND VALIDATION FOR HYPERSONIC INLETS
Povinelli, Louis A., NASA Lewis Research Center, USA; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 10p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Hypersonic inlet research activity at NASA is reviewed. The basis for the paper is the experimental tests performed with three inlets: the NASA Lewis Research Center Mach 5, the McDonnell Douglas Mach 12, and the NASA Langley Mach 18. Both three-dimensional PNS and NS codes have been used to compute the flow within the three inlets. Modeling assumptions in the codes involve the turbulence model, the nature of the boundary layer, shock wave-boundary layer interaction, and the flow spilled to the outside of the inlet. Use of the codes and the experimental data are helping to develop a clearer understanding of the inlet flow physics and to focus on the modeling improvements required in order to arrive at validated codes.
Author
Hypersonic Inlets; Mach Number; Inlet Flow; Flow Distribution; Turbulence Models; Shock Wave Interaction; Pressure Distribution; Computational Fluid Dynamics

19970010666 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
INTEGRATED AIRFRAME DESIGN TECHNOLOGY *LES TECHNOLOGIES DE LA CONCEPTION INTEGREE DES CELLULES*
Integrated Airframe Design Technology; Oct. 1996; 174p; In English; In French; 82nd; Structures and Materials Panel, 8-9 May 1996, Sesimbra, Portugal; See also 19970010667 through 19970010680 Report No.(s): AGARD-R-814; ISBN 92-836-0030-4; Copyright Waived; Avail: CASI; A08, Hardcopy; A02, Microfiche

Integrated airframe design embraces the concept of bringing together all of the aspects of airframe design, including various disciplines such as structures, materials, aerodynamics, propulsion, systems, controls, and manufacturing from conceptual design all the way through to the final product and its repair and maintenance. The results of this AGARD Workshop on Integrated Airframe Design emphasized that the recent and future advances in high-performance computer hardware and software systems provide the opportunity to create a process that will allow these disciplines to rapidly interact with one another.
Author
Multidisciplinary Design Optimization; Airframes; Computer Aided Design; Design Analysis; Concurrent Engineering; Finite Element Method; Structural Design; Structural Analysis; Conferences; Computer Programs

19970010667 Northrop Grumman Corp., Pico Rivera, CA United States
INTEGRATED AIRFRAME DESIGN TECHNOLOGY AT NORTHROP GRUMMAN
Wiley, Dianne, Northrop Grumman Corp., USA; Integrated Airframe Design Technology; Oct. 1996; 9p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Design for affordability is the new paradigm for the 21st Century. Balancing the conflicting goals of systems superiority and systems affordability is the challenge of multidisciplinary design optimization on a larger scale than has ever been done before. Addressing the realities of he future aerostructures business has led to a new vocabulary. Northrop Grumman pioneered many of these concepts on the B-2 Program during the 1980's. Since then we have taken the lessons learned, coupled with commercial off the shelf software and integrated them into formal protocols for affordable aircraft production, resulting in a Toolbox for Affordable Production.
Author
Multidisciplinary Design Optimization; Aircraft Production; Computer Aided Manufacturing; Airframes; Computer Aided Design

19970010668 Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX United States
INTEGRATED AIRFRAME DESIGN AT LOCKHEED MARTIN TACTICAL AIRCRAFT SYSTEMS
Love, Michael H., Lockheed Martin Tactical Aircraft Systems, USA; Oct. 1996; 12p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Airframe product design integration is continuously evolving with the goal of facilitating the design team's mission; development of 'build-to' datasets that provide the complete definition of hardware to be manufactured. This paper surveys design tools, practices, and strategies in Lockheed Martin Tactical Aircraft System's (LMTAS) integrated environment. Airframe design is a set of structured and chaotic processes coordinated to establish product function and fit, affordability, producability, and structural certification. Integration encompasses the data development, data transfer, and knowledge development necessary to create the product. Evolution of integrated design at LMTAS is resulting from influx of advanced technologies such as scientific visualization, multidisciplinary analysis and optimization, and data exchange standards. Illustrations of advanced technologies and their implementation at Lockheed Martin Tactical Aircraft Systems are provided in the context of conceptual design, preliminary design and detailed design. New aircraft design programs offer opportunities.
Author
Aircraft Design; Airframes; Scientific Visualization; Multidisciplinary Design Optimization; Computer Aided Design

19970010669 Daimler-Benz Aerospace A.G., Munich, Germany
A COMMON FRAMEWORK ARCHITECTURE FOR AN INTEGRATED AIRCRAFT DESIGN
Krammer, J., Daimler-Benz Aerospace A.G., Germany; Vilsmeier, J., Daimler-Benz Aerospace A.G., Germany; Schuhmacher, G., Siegen Univ., Germany; Weber, C., Siegen Univ., Germany; Oct. 1996; 10p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The paper first describes the architecture of the framework and the processes which are implemented. After that the concept of a common optimization model formulation based on the design element method and its integration in the overall process is explained. As an example for the so-called 'constructive design model' the optimal layout of a stiffened panel under buckling loads is considered.
Author
Aircraft Design; Multidisciplinary Design Optimization; Computer Aided Design; Architecture (Computers)

19970010670 British Aerospace Defence Ltd., Preston, United Kingdom
INTEGRATED AIRFRAME DESIGN TECHNOLOGY
Thompson, D., British Aerospace Defence Ltd., UK; Oct. 1996; 6p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Multi-disciplinary Design Optimization (MDO) requires sensitivities and model data to be handled among many applications, such as FE and CFD codes. Each iteration to the optimum design requires a re-execution of some of the applications, presenting a new input data and receiving updated sensitivities. All this takes place within applications moving from a central mainframe to numerous UNIX workstations. Therefore, in order to perform MDO one has to solve problems of transferring data and executing remote applications. Most applications are to be available during a lengthy optimization process, which affects the reliability of networks and computers. This paper will outline our vision of MDO and detail our work and problems in performing: remote application execution; data transfer over local and wide networks; network topology to give redundant data paths; redundant computers via multiple application installations; real-time interactive guidance of the optimization process; and dynamically linking distributed applications to parallelize the optimization process across workstations and supercomputers.
Author
Airframes; Multidisciplinary Design Optimization; Data Transfer (Computers); Computer Systems Performance; Real Time Operation

19970010672 Aerospatiale, Paris, France
A CONCURRENT ENGINEERING PRODUCT- AIRBUS AIRCRAFT TECHNOLOGY *DEVELOPPEMENT ET INGENIERIE SIMULTANEE- LES PRODUITS AIRBUS*
Carcasses, A., Aerospatiale, France; Oct. 1996; 11p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Aspects of concurrent engineering relating to European Airbus are described.
Derived from text
Concurrent Engineering; European Airbus; Product Development

19970010673 Dassault Aviation, Saint-Cloud, France
DESIGN AND ANALYSES OF AIRFRAMES *CONCEPTION ET ANALYSES DES CELLULES*
Petiau, Christian, Dassault Aviation, France; Oct. 1996; 11p; In French; See also 19970010666; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

We present the process of drawing-analysis interactions for airframes design, based on the capabilities of our coupled CAD analysis tools CATIA and ELFINI: (1) for preliminary project, global definition of airframe by CATIA objects associated with a global Finite Element model and with a mathematical optimization of the dimensioning; many, fast and cheap evaluations of alternate architectures are possible; and (2) for development phase, detail drawings of parts with CAD 'solid' models, lay-out studies with a digital mock-up, verifications by non linear finite element analyses or by partial tests; the present difficulty of the process restricts design iterations. Due to limitations of numerical means and of partial tests, the demonstration of structure qualification must be jointly founded on general tests (flight tests, static test airframe). Prospects of tool development are revoked: multidisciplinary and multilevel optimizations, availability of repeatable Design Historical Records, Feature Modeling generalized to analyses and to optimization. These tools will provide more means for iterations at every project stage, they allow to fully master costs, time and risks in project development phases; yet they present the problem of preservation of innovation capability with the full standardization of designs and processes.
Author
Airframes; Computer Aided Design; Finite Element Method; Mathematical Models

19970010674 Rockwell International Corp., North American Aircraft Div., Seal Beach, CA United States
AUTOMATED STRUCTURAL ANALYSIS PROCESS AT ROCKWELL
Dobbs, S. K., Rockwell International Corp., USA; Schwanz, R. C., Rockwell International Corp., USA; Abdi, F., Alpha STAR Corp., USA; Oct. 1996; 12p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

An automated and integrated structural design and analysis process for aircraft and weapons airframes is described. The primary purpose of the process is to reduce design cycle time and to tie structural design and performance to 'design to cost' analyses. This capability is included in a general system, called the Affordable Systems Optimization Process (ASOP), which includes five separate, but linked systems: The 'Design to Cost' Tool, Automated Structural Analysis Process (ASAP), an ultra rapid finite element model generator and transformation pre/post processor (COMETRAN), Active Aeroelastic Wing Optimizer (AAW), and CFD based static and dynamic aeroelasticity (ENSAERO). This evolving system has already significantly reduced structural design cycle time, and is being expanded to include more design disciplines.
Author
Structural Analysis; Structural Design; Airframes; Design to Cost; Aeroelasticity; Computational Fluid Dynamics; Multidisciplinary Design Optimization; Aircraft Design

19970010675 Construcciones Aeronauticas S.A., Stress Dept., Madrid, Spain
A SIMPLIFIED APPROACH TO THE MULTIDISCIPLINARY DESIGN OPTIMIZATION FOR LARGE AIRCRAFT STRUCTURES
Morell, Miguel Angel, Construcciones Aeronauticas S.A., Spain; Huertas, Manuel, Construcciones Aeronauticas S.A., Spain; Gomez, Jose Carlos, Construcciones Aeronauticas S.A., Spain; Oct. 1996; 12p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The last tendencies in optimization indicate that in early design stages, it is necessary to perform multidisciplinary analysis for designing large structures. This paper presents a simple but very efficient tool that CASA is using during the preliminary stages of the aircraft structural design for defining and selecting the structural characteristics. The development of this software package, ALACA, was undertaken by CASA Engineering Directorate in the last years for the purpose of designing the composite wing of CASA 3000 Aircraft. ALACA optimizes wing structures satisfying all the structural requirements (weights, static loading, material, fatigue, residual strength, manufacturing, flutter, etc.). The main advantage of the program is that it is not necessary to use finite element techniques, which make it easier than other available codes and allows to use it in the earliest phases of the project (preliminary design) before freezing the general arrangement of the structure. The results from the CASA 3000 studies show the reliability and efficiency of ALACA as a design tool.
Author
Multidisciplinary Design Optimization; Aircraft Structures; Aircraft Design; Applications Programs (Computers)

19970010676 Vrije Univ., Analyse van Strukturen, Brussels, Belgium
MONTE CARLO-BASED STOCHASTIC FINITE ELEMENT METHOD: A NEW APPROACH FOR STRUCTURAL DESIGN
vanVinckenroy, G., Vrije Univ., Belgium; deWilde, W. P., Vrije Univ., Belgium; Vantomme, J., Royal Military Academy, Belgium; Oct. 1996; 12p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The paper summarizes the principles of the Monte Carlo based finite element method. The method relies on the characterization, by means of stochastic tools, of the mechanical behavior of different materials with uncertainties taken into account. A procedure based on the combination of three methods for estimating distribution parameters has been set up to ensure a correct estimation of the material properties that are used as input for the finite element model. The stochastic engineering design method is then applied to beam structures. Although the present report is limited to the linear analysis, it is concluded that attention should be paid to the Monte Carlo sample size required to obtain accurate results and to the appropriate choice of the finite element mesh to avoid excessive CPU time consumption and errors in the interpretation of the results.
Author
Monte Carlo Method; Finite Element Method; Structural Design; Composite Structures; Probability Distribution Functions

19970010677 Wright Lab., Aero Propulsion and Power Directorte; Turbine Engine Div., Wright-Patterson AFB, OH United States
THE GAS TURBINE ENGINE CONCEPTUAL DESIGN PROCESS: AN INTEGRATED APPROACH
Stricker, Jeffrey M., Wright Lab., USA; Oct. 1996; 7p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The conceptual design of gas turbine engines is a complex process which crosses many engineering disciplines. Aerodynamics, thermodynamics, heat transfer, materials design/selection, and structural analysis are a few of the fields employed when downselecting an appropriate engine configuration. Because of the complexity involved, it is critical to have a process which narrows engine options without missing the 'optimum' engine design. The following paper will describe a typical process used at the conceptual design level. Various steps which will be described include propulsion requirements definition, uninstalled engine cycle performance, component design, engine flowpath/weight prediction, installation effects, and the influence of engine design trades on aircraft size and performance. The engine design process is not completely linear. The steps listed above are highly interdependent. A number of iterations are usually necessary in selecting a final engine design. This paper will describe several of the interrelationships between the various steps. Frequently, the engine conceptual design process has special considerations which require additional engine analyses. Some modern day examples of these criteria include reduced observables and cost reduction. How these variations are incorporated into the conceptual design process will be discussed.
Author
Gas Turbine Engines; Engine Design; Aircraft Engines; Performance Prediction

19970010678 Instituto Nacional de Tecnica Aeroespacial, Madrid, Spain
COMPUTATIONAL ASSESSMENT ON INTEGRATED ANALYSIS AND DESIGN
Conca, J. M. G., Instituto Nacional de Tecnica Aeroespacial, Spain; Oct. 1996; 6p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

One important question in analysis and design is how much error (e(sub N)) has the solution (x(sub N))? The answer is very difficult even if limited strictly to the computation. For two decades the author has researched and developed a Procedure in the University and the INTA to give an answer acceptable to Industry. This paper gives the Fundamentals and Applications to two Aerospace Projects: (1) Airplane: C(sub L alpha) (C(sub L) slope); and (2) Satellite: lambda(sub min) (min eigenvalue) whose solutions (x) are unknown, but they can be computed as shown.
Author
Analysis (Mathematics); Error Analysis; Convergence; Procedures

19970014109 Boeing Commercial Airplane Co., Aerodynamics Engineering, Seattle, WA United States
THE DYNAMIC RESPONSE OF A TWIN-ENGINE, COMMERCIAL JET TRANSPORT TO WAKE VORTEX ENCOUNTERS
Vasatka, James, Boeing Commercial Airplane Co., USA; Nov. 1996; 12p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In order to refine existing wake-vortex separation distances through the application of technology, the issues associated with defining the basis for separation criteria must be addressed. This includes understanding the significance of a wake vortex encounter. The results from this study suggest that the airplane's response is dependent on the flight path through the wake.
Derived from text
Dynamic Response; Wakes; Vortices; Transport Aircraft

19970014119 CFD Norway A/S, Trondheim, Norway
ON THE INTERACTION BETWEEN TOPOGRAPHICAL WIND AND LANDING AIRCRAFT
Kubberud, Nils, CFD Norway A/S, Norway; Oye, Ivar, CFD Norway A/S, Norway; Norstrud, Helge, Norwegian Univ. of Science and Technology, Norway; Nov. 1996; 12p; In English; See also 19970014096; Original contains color illustraions; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The present paper gives a qualitative study of the flow interaction between a representative landing aircraft and the wind induced vortical flow. Separate numerical analysis for the wind flow over the given terrain and the flow structure around the lifting airplane is given. The interaction is performed by superposing the two solutions in various crossflow planes along the glide path direction of the aircraft. This leads to an estimate of the change of circulation for the lifting body and the associated need for corrective control forces.
Author
Numerical Analysis; Lifting Bodies; Glide Paths

19970014131 Technische Univ., Inst. fur Stromungsmechanik, Brunswick, Germany
THE USE OF AIRCRAFT WAKES TO ACHIEVE POWER REDUCTIONS IN FORMATION FLIGHT
Hummel, Ing. D., Technische Univ., Germany; Nov. 1996; 13p; In English; See also 19970014096
Contract(s)/Grant(s): DFG-Hu254/10; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Many migrating bird species fly in regular V-shaped formations. Each wing experiences an upwash field generated by all other wings in the formation and this leads to a reduction in flight power demand for each wing as well as for the whole formation. In this paper the aerodynamic interference is studied by means of aerodynamic theory. The total energy saving for the whole formation increases with the number of wings and with decreasing lateral distance. Local power reductions are highest in the inner parts of a for nation and they decrease towards the apex and the side-edges. The technical realization of this principle is analysed for two airplanes. In calibration flights of gliders large distances have to be kept or the aerodynamic interference has to be taken into account. In formation flights of two airplanes a power reduction of 15% is obtainable for the rear airplane flying close to the wake of the front aircraft. The corresponding aileron and rudder deflections for compensation of the corresponding moments are small. Flight tests with two airplanes Do-28 show that the power reduction can be achieved in practical flight. The results are in excellent agreement with aerodynamic theory. In order to enable the rear airplane to find the proper position relative to the wake of the front airplane an automatic control system has been adapted. A formation flight controller has been designed which leads the upwash in the symmetry plane and the aileron deflections to maximum values. The application of this control system led to a considerable relief of the pilot and important power reductions could be achieved automatically.
Author
Aerodynamic Interference; Aerodynamics; Aircraft Wakes; Flight Control; Upwash

19970014132 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
ON THE DYNAMICS OF ENGINE JETS BEHIND A TRANSPORT AIRCRAFT
Jacquin, L., Office National d'Etudes et de Recherches Aerospatiales, France; Garnier, F., Office National d'Etudes et de Recherches Aerospatiales, France; The Characterisation and Modification of Wakes from Lifting Vehicles in Fluids; Nov. 1996; 8p; In English; See also 19970014096; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The various mechanisms that contribute to the mixing and dispersion of the engine exhausts through their interaction with the vortex wake of an aircraft are discussed. The case of a typical large transport aircraft is considered. First, the interaction between the jets and the vortices is characterized by means of non dimensional parameters. When considering aircraft under cruise conditions, it is shown the jets have almost no effect on the vortex wake dynamics. We then consider the way the jet is changed by the vortices. This is evaluated by means of an integral model. Examples are given which show that the jet is captured by the vortices at very different distances behind the aircraft depending on the engine-wingtip separation. The model does not take into account the distortion of the jet plume by the vortex shearing which becomes significant when the jet reaches the vortex center region. Results of a numerical simulation of the convection-diffusion of a passive scalar field, as well as a visualisation realized during an experiment are presented in order to illustrate this point.
Author
Transport Aircraft; Aircraft Engines; Wing Tips; Vortices

19970018627 NFT, Kongsberg, Norway
PENGUIN MK2 MOD7 INTEGRATION IN THE SIKORSKY S-70B HELICOPTER INTEGRATION AND LIVE FIRE TESTING
Sollie, Are Christian, NFT, Norway; Spitz, Steve, Sikorsky Aircraft, USA; Nov. 1996; 18p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The paper describes the Penguin MK2 MOD7 (AGM-119B) antiship missile integration in the Sikorsky S-70B helicopter. Innovative design techniques allowed use of existing aircraft and missile hardware. Only software development was required to integrate the Penguin missile with the S-70B aircraft. The paper discusses briefly the system integration testing and presents some of the test results. The system integration testing was based on extensive simulation of mathematical models and a low-cost instrumentation of a captive carry flight test range in the Long Island Sound, USA. Finally, some test results from a live firing demonstration performed at USN NAWCAD, Patuxent River are given.
Author
Systems Integration; Sikorsky Aircraft; Helicopters; Air to Surface Missiles; Flight Tests; Captive Tests; Computer Programs

19970018631 Scientific and Technical Research Council of Turkey, Defense Industries Research and Development Inst., Ankara, Turkey
LINEAR STABILITY ANALYSIS OF UNGUIDED MISSILES WITH WRAP-AROUND TAIL FINS IN FREE FLIGHT
Tanrikulu, O., Scientific and Technical Research Council of Turkey, Turkey; Onen, C., Scientific and Technical Research Council of Turkey, Turkey; Mahmutyazicioglu, G., Scientific and Technical Research Council of Turkey, Turkey; Bektas, I., Scientific and Technical Research Council of Turkey, Turkey; Nov. 1996; 13p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A large number of tube launched unguided missiles of NATO such as 70 mm Mk 66, 122 mm FIROS, 127 mm Mk 71, 160 mm RAYO and 227 mm MLRS have wrap-around tail fins (WAF). These missiles have more complicated flight mechanics when compared to the ones with flat and straight tail fins. This is due to the fact that WAF lack mirror symmetry. Detailed free flight mechanics analysis of such missiles were performed with particular emphasis given to the effect of out-of-plane static moment stability derivative C(sub m beta) on dynamic stability. In this study, combined effects of C(sub m beta) and Magnus moment stability derivative C(sub m beta(sub p)) on dynamic stability are explored. Aerodynamics and flight mechanics of a simple configuration with WAF are examined as a case study.
Author
Missile Configurations; Free Flight; Stability Derivatives; Dynamic Stability; Magnus Effect; Numerical Analysis

19970018640 Georgia Tech Research Inst., Atlanta, GA United States
ENABLING TECHNOLOGY FOR UAVS
Michelson, Robert C., Georgia Tech Research Inst., USA; Nov. 1996; 10p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Requirements for the performance of certain NATO missions in the 2015 - 2020 time frame have been examined. In addition, various unmanned aerial vehicle-borne sensor payloads have been identified which support the execution of these missions in an effective manner. Present state-of-the-art sensors and air vehicle systems do not provide the performance necessary to prosecute these missions in light of the anticipated future civil and military environment. This paper presents a discussion of the under-girding technologies which will make the predicted Unmanned Aerial Vehicle (UAV) performance possible. The description of these enabling technologies includes discussions concerning the present state of the art, their general applicability to a variety of UAV payloads, and the collateral technologies which will in turn facilitate the development of the chosen primary enabling technologies. Though a number of enabling technologies have application to the various UAV missions, seven are recommended for near term investment.
Derived from text
Mission Planning; North Atlantic Treaty Organization (NATO); Payloads; Pilotless Aircraft; Remote Sensors

19970018642 Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX United States
UNMANNED TACTICAL AIRCRAFT: A LOCKHEED MARTIN PERSPECTIVE
Chaput, Armand J., Lockheed Martin Tactical Aircraft Systems, USA; Albin, Timothy S., Lockheed Martin Tactical Aircraft Systems, USA; Hosmer, Douglas M., Lockheed Martin Tactical Aircraft Systems, USA; Weigel, Stephen R., Lockheed Martin Tactical Aircraft Systems, USA; Nov. 1996; 18p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Unmanned Tactical Aircraft (UTA) is described according to the Lockheed Martin perspective. This perspective contains a wide range of concepts including: th Lockheed Martin definition of an UTA; benefits; phased program approach; "reusables" vs. "expendables"; missile or fighter?; and an overall advanced UTA concept.
Derived from text
Pilotless Aircraft; Weapons Delivery

19970018646 MATRA Defense Espace, Advanced Studies Div., Velizy-Villacoublay, France
THE MARVEL MARITIME UAV
Pelous, Jean-Francois, MATRA Defense Espace, France; Barlow, Jewel B., Maryland Univ., USA; Nov. 1996; 10p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In the first part, we review the essential requirements for a UAV system marine use. Then, we present some of the specific Freewing TilitBody MARVEL aerodynamic characteristics and a short description of the landing system equipment used during the ship deck approach.
Author
Landing Aids; Pilotless Aircraft

19970018647 Bombardier, Inc., Systemes de Defense Div., Montreal, Quebec Canada
CONCEPTION AND DEVELOPMENT OF AN AUTOMATIC MARITIME SYSTEM USING A GENERIC VEHICLE OF THE VTOL TYPE
CONCEPTION ET DEVELOPPMENT D'UN SYSTEME D'APPONTAGE MARITIME AUTOMATIQUE D'UN VEHICULE GENERIQUE DE TYPE VTOL
deFerrier, Bernard, Bombardier, Inc., Canada; Reboulet, Claude, Centre d'Etudes et de Recherches, France; Nov. 1996; 8p; In French; See also 19970018626; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The evolution of an automated ship recovery system for a VTOL UAV is discussed. The generic UAV model is based on the Canadair CL227 VTOL UAV. Test results concentrating on system control and response are provided. A description of the data link software and hardware components is presented . The approach describing the location of the air vehicle is based on the decompostion of the state vector into observable and non-observable components. This approach is validated by simulation. The simulation model is based on a six degree-of-freedom representation of the air vehicle, the ship, the data link system and the environment. The data link/recovery system uses vehicle control and ship motion algorithms which close the loop between the air vehicle and ship. Finally, the flight profiles produced by simulation are also discussed.
Author
Ships; Vertical Takeoff Aircraft; Remotely Piloted Vehicles; Systems Engineering; Flight Safety; Computerized Simulation; Control Systems Design

19970018648 Turkish Aerospace Industries, Design and Development Dept., Ankara, Turkey
TURKISH UNMANNED AIR VEHICLE DEVELOPMENTS
Kaynak, Unver, Turkish Aerospace Industries, Turkey; Nov. 1996; 10p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

There is an increase in understanding of the benefits of using UAV's under certain scenarios. Acquisition of operational UAV's for the Turkish military, and lessons learned from recent conflicts in some troubled areas of the world, give impetus to gaining some domestic expertise on the design and operation of drones. Under contract by the Undersecretariat of Defense Industries TAI designed, developed and flight tested two line-of-sight UAV prototypes between 1990-1992. The intent was firstly to demonstrate TAI's design capabilities, and later, to

further develop the vehicles into mission capable vehicles by the addition of certain operational functions and mission payloads. The project was successfully completed with the delivery of the vehicles that had limited capabilities. TAI was responsible for the design and development of the airframe, systems integration, and ground and flight tests. Commercially available avionics systems were used in the ground control station and in the aircraft. The project enhanced the in-house knowledge base pertaining to unmanned air vehicles quite significantly, and encouraged the start of further activities that included target drones. Under the contract with MOD, TAI is currently developing a new target drone, TAI-UKHU, for use with the air defense units. In this paper, basically, TAI's efforts will be summarized which cover the UAV-X 1 and the UKHU target drone.
Author
Remotely Piloted Vehicles; Drone Vehicles; Avionics; Airframes; Aircraft Design; Systems Engineering

19970019673 Bell Helicopter Co., Structures Research and Development, Fort Worth, TX United States
TILTROTOR TRANSPORT BONDED WING DESIGN SUMMARY
Dompka, Robert V., Bell Helicopter Co., USA; Holzwarth, Richard C., Wright Lab., USA; Jan. 1997; 12p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper presents the results of research and development activities conducted under Air Force contract by Bell Helicopter Textron, Inc. (Bell) to apply advanced design and manufacturing technology to reduce production costs of a composite tiltrotor transport vehicle wing. Strength, stiffness, and weight requirements dictated the utilization of advanced composites. This paper will provide a description of the effects of these requirements on wing torque box design and the analysis used to size major structural components and joints. Component verification test results are provided to support the design decisions and validate the analyses and structural integrity. Future plans are presented for a full-scale torque box structural test as demonstration of the viability of the final design.
Author
Bell Aircraft; Aircraft Design; Wings; Structural Failure; Structural Design; Helicopters; Composite Structures; Composite Materials

19970025162 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
COOPERATIVE PROGRAMME ON DYNAMIC WIND TUNNEL EXPERIMENTS FOR MANOEUVRING AIRCRAFT *PROGRAMME EN COOPERATION SUR L'EXPERIMENTATION DYNAMIQUE EN SOUFFLERIE POUR LA MANOEUVRABILITE DE L'AVION*
Oct. 1996; 248p; In English; Original contains color illustrations
Report No.(s): AGARD-AR-305; ISBN 92-836-1043-1; Copyright Waived; Avail: CASI; A11, Hardcopy; A03, Microfiche

This report describes a multinational cooperative program in response to the continuing interest among the NATO countries in dynamic wind tunnel testing. The program consisted of a series of dynamic experiments on models of a schematic combat aircraft configuration and of two generic aircraft forebodies. Ten wind tunnels in seven countries were involved. The dynamic tests included oscillatory, and in one case oscillatory-coning experiments. In several facilities, this was complemented by static and, in some cases, also dynamic flow visualization experiments in water tunnels. The forebody experiments included extensive surface pressure measurements under rotary conditions, carried out in a pressurized wind tunnel. The reliability of current test techniques was examined; and an expanded data base for dynamic data at high angles of attack is presented.
Author (revised)
Wind Tunnel Tests; Dynamic Tests; Angle of Attack; Fighter Aircraft; Flow Visualization; Pressure Measurement; Reynolds Number

19970025403 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
ADVANCES IN ROTORCRAFT TECHNOLOGY *LES AVANCEES EN TECHNOLOGIES POUR AERONEFS A VOILURE TOURNANTE*
Advances in Rotorcraft Technology; Apr. 1997; 392p; In English; In French, 27-30 May 1996, Ottawa, Canada; See also 19970025404 through 19970025434
Report No.(s): AGARD-CP-592; ISBN 92-836-0038-X; Copyright Waived; Avail: CASI; A17, Hardcopy; A04, Microfiche

The last half of the twentieth century has seen the rotorcraft come in to prominence as a combat system. Rotorcraft have proven their worth in all environments and in all domains of conflict. They will continue to provide essential military capabilities for the Alliance well into the next century. The objective of this symposium was to capture the current situation in the rapidly changing field of rotorcraft technology. The symposium met its objective. Different parts of this Conference Proceedings should be valuable to anyone currently designing or developing rotorcraft, or doing basic research in rotorcraft technology. Special emphasis in the programme was placed upon the following subjects: (1) the impact of the increasing use of commercial off-the-shelf technology in military helicopter development and use; (2) the increasing acceptance and expanded use of Aeronautical Design Standard ADS-33; and (3) the issue of rotorcraft flight safety. This symposium provided an excellent forum for a varied program of technical presentations. It specifically provided information on the Bell 230, the Tiger, Eurocopter EC 135, the V-22, and the RAH Comanche. The knowledge gained and exchanged at this symposium should assist the attendees in helping to provide NATO with the future affordable combat rotorcraft it will need to maintain our current technological lead.
Author
Conferences; Flight Safety; Helicopter Design; Standardization; Helicopter Performance; Rotary Wing Aircraft

19970025404 Textron Bell Helicopter, Mirabel, Quebec Canada
CERTIFICATION OF MODEL 230 HELICOPTER FOR CATEGORY A ELEVATED HELIPAD OPERATIONS
Goldenberg, Joachim, Textron Bell Helicopter, Canada; Meslin, L., Textron Bell Helicopter, Canada; Blondino, M., Textron Bell Helicopter, USA; Williams, D., Textron Bell Helicopter, USA; Advances in Rotorcraft Technology; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A flight test program leading to the certification of Model 230 helicopter for Category A elevated heliport operations was conducted. This paper discusses the development of the TakeOff and Landing profiles for Transport Helicopters operating from elevated helipads. The development included simulation, ground level helipad tests, and elevated helipad testing. Also presented are the demonstrated helicopter performances for this type of operations. The developed procedures will enable operators to plan for Category A operations from elevated heliports.
Author
Helicopters; Aircraft Reliability; Flight Safety; Certification; Takeoff; Aircraft Landing; Helicopter Performance; Helicopter Design

19970025405 Defence Research Agency, Flight Dynamics and Simulation Dept., Bedford, United Kingdom
THE USE OF SIMULATION TO DEVELOP AN IMPROVED UNDERSTANDING OF HELICOPTER TAIL ROTOR FAILURES AND DEVELOP AIRCREW EMERGENCY ADVICE
Martyn, A. W., Defence Research Agency, UK; Phipps, P., Westland Helicopters Ltd., UK; Mustard, E., Westland Helicopters Ltd., UK; Apr. 1997; 18p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper reviews the use of simulation in recent UK programmes to improve our understanding of helicopter tail rotor failures, and develop the handling advice for aircrew following a tail rotor (TR) malfunction. The paper discusses the original motivation for the work and in particular the research work that has been carried out by the Defence Research Agency (DRA) and Westland Helicopters Ltd (WHL) under UK Ministry of Defence (MOD) funded programmes. This research has included flight trials conducted on the DRA Aeromechanics Lynx Control and Agility Testbed (ALYCAT) to develop Lynx TR control failure handling advice, and simulation trials on the DRA Bedford Advanced Flight Simulator (AFS) to develop Lynx TR drive failure handling advice. The AFS was also used to investigate the influ-

ence of helicopter design parameters on a pilot's ability to recover from a TR failure. Also described are off-line simulation and model development activities. The paper concludes with a review of lessons learnt.
Author
Helicopter Tail Rotors; Helicopter Design; Helicopters; System Failures; Failure Analysis; Simulation; Flight Hazards; Accident Prevention

19970025406 NASA Ames Research Center, Moffett Field, CA United States
OPTIMAL TRAJECTORIES FOR THE HELICOPTER IN ONE-ENGINE-INOPERATIVE TERMINAL-AREA OPERATIONS
Chen, Robert T. N., NASA Ames Research Center, USA; Zhao, Yi-Yuan, Minnesota Univ., USA; Apr. 1997; 28p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents a summary of a series of recent analytical studies conducted to investigate one-engine-inoperative (OEI) optimal control strategies and the associated optimal trajectories for a twin engine helicopter in Category-A terminal-area operations. These studies also examine the associated heliport size requirements and the maximum gross weight capability of the helicopter. Using an eight states, two controls, augmented point-mass model representative of the study helicopter, continued takeoff (CTO), rejected takeoff (RTO), balked landing (BL), and continued landing (CL) are investigated for both vertical-takeoff-and-landing (VTOL) and short-takeoff-and-landing (STOL) terminal-area operations. The formulation of the non-linear optimal control problems with considerations for realistic constraints, solution methods for the two-point boundary-value problem, a new real-time generation method for the optimal OEI trajectories, and the main results of this series of trajector optimization studies are presented. In particular, a new balanced-weight concept for determining the takeoff decision point for VTOL Category-A operations is proposed, extending the balanced-field length concept used for STOL operations.
Author
Helicopter Engines; Optimal Control; Engine Failure; Helicopter Performance; Boundary Value Problems; Real Time Operation; Flight Hazards; Helicopter Control; Trajectory Optimization; Helicopters

19970025407 Atlantis Aerospace Corp., Brampton, Ontario Canada
AN INVESTIGATION OF PRIMARY FLIGHT CONTROL FAILURE IN A PILOTED HELICOPTER
Gibbard, Scott R., Atlantis Aerospace Corp., Canada; Reid, L. D., Toronto Univ., Canada; Apr. 1997; 12p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The application of fly-by-wire techniques to helicopters allows for a number of advanced control schemes that can be used to enhance performance and safety. An experiment has been carried out in a manned helicopter simulator to evaluate the possibility of making use of such a system to allow the pilot to retain control over the helicopter following catastrophic failure of the lateral cyclic primary control. It was demonstrated that a pilot can switch to pedals as the lateral control input provided that the tail rotor is controlled by an autopilot mode. The feasibility of this process has been evaluated for a range of system configurations and the corresponding handling qualities ratings are reported.
Author
Helicopters; Flight Control; System Failures; Flight Safety; Fly by Wire Control; Lateral Control; Helicopter Control; Controllability; Pilot Performance; Flight Hazards; Manual Control

19970025408 Centre d'Essais en Vol, Section et Simulation, Istres, France
MISSION SIMULATION FOR TIGRE (PROTECTION SUPPORT VERSION) ***SIMULATION DE MISSION POUR LE TIGRE (VERSION APPUI PROTECTION)***
Rigal, J. F., Centre d'Essais en Vol, France; Colas, G., Centre d'Essais en Vol, France; Advances in Rotorcraft Technology; Apr. 1997; 10p; In French; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

As part of the development of the support-protection helicopter version of the TIGRE helicopter, an evaluation of the specifications of the mission system was performed. The prior phases made it possible to tackle aspects pertaining to the crew-system interface, as well as the symbols and procedures relating to piloting, navigation, and employment of armament, including degraded modes and the integration of specific equipment units into the support-protection version within the basic TIGRE system. This developmental phase made it possible to perform mission simulations, thus ensuring the overall check on the crew workload under conditions as close as possible to real-life missions.
Transl. by SCITRAN
Helicopters; Flight Simulation; Flight Crews; Helicopter Design; Air Navigation

19970025409 CAE Electronics G.m.b.H., Stolberg, Germany
MODULAR ROLL-ON/ROLL-OFF DESIGN CONCEPT OF A ROTORCRAFT SIMULATION CENTER
Niessen, Klaus, CAE Electronics G.m.b.H., Germany; Apr. 1997; 6p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

It must be the objective of the army aviation corps flight training to enable helicopter pilots to use their weapon system safely and efficiently by using the technical equipment and possibilities: at day and night, in air mobile combat of combined arms, and under almost all possible weather conditions. This is done in the so-called training equipment compound where the adequate training equipment is assigned to the respective training objective. Partial skills are learned by means of simple procedure trainers and handling models before complex simulators and finally the original device, the helicopter, are used to merge the partial skills. This training equipment compound allows to reduce costs and at the same time to reach those training objectives which will be demanded in the future. Training equipment essentially consists of the following: (1) CBT is an interactive computer based training equipment which is used for interactive learning of flight theoretical and technical aircraft knowledge, navigation training and radio communications. (2) Part Task Trainers are used for hands-on training of partial capabilities. They are corresponding to the respective system in design, layout and operation. (3) Flight Simulators and Combat Mission Simulators will be treated in detail during the further explanations. (4) The close-in combat simulator (AGDUS) corresponds to the common equipment of the army. (5) SIRA, the common equipment for combat simulation, must be extended to allow for the command and control of operations of air-mobile forces. (6) The basic training helicopter (SHS) is an indispensable equipment for the basic and advanced training of aircrews. The helicopter is not replaceable - especially with regard to affect training objectives.
Author
Rotary Wing Aircraft; Flight Simulators; Flight Training; Flight Crews; Helicopter Control; Helicopter Design; Air Navigation; Training Devices; Roll

19970025410 Centre d'Essais en Vol, Istres, France
EVALUATION OF TRANSPORT HELICOPTER PILOTING CAPACITY, USING IN-FLIGHT TESTS OF THE ADS-33C TYPE: FORMAL ESTABLISHMENT OF THE TEST METHODOLOGY AND INSTRUMENTATION ***EVALUATION DE LA PILOTABILITE DES HELICOPTERES DE TRANSPORT EN UTILISANT LES ESSAIS EN VOL DE TYPE ADS-33C: FORMALISATION DE LA METHODOLOGIE ET DE L'INSTRUMENTATION D'ESSAIS***
Fournier, D., Centre d'Essais en Vol, France; Papillier, D., Centre d'Essais en Vol, France; Apr. 1997; 12p; In French; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Flight tests, of the type of those proposed by ADS033, are performed to evaluate piloting capacity during the developing and testing of transport helicopter. Based on the results of an experiment conducted on SA332 Super Puma MK 2 helicopter, this document attempts to present a methodology and the resources for the necessary tests.
Transl. by SCITRAN
Helicopter Design; Flight Tests; Helicopters; Pilots (Personnel); Helicopter Control; Maneuverability

19970025411 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Flight Mechanics, Brunswick, Germany
ADS-33 FLIGHT TESTING: LESSONS LEARNED
Ockier, Carl J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Gollnick, Volker, Bundesamt fuer Wehrtechnik und Beschaffung, Germany; Apr. 1997; 12p; In English; See also

19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A comprehensive evaluation of the ADS-33D handling qualities specification for military rotorcraft was completed with the BO 105 helicopter. The evaluation addressed both the quantitative and qualitative ADS-33 criteria. The evaluation of the quantitative or open-loop criteria in hover and in forward flight directly addressed applicability and repeatability of the criteria. The evaluation of the qualitative criteria or ADS-33 flight test maneuvers in the good visual environment addressed applicability and validity issues. This paper presents some of the major results of the quantitative and qualitative evaluations and extracts some lessons from the comparison of the results of both evaluations.

Author

Rotary Wing Aircraft; Flight Tests; Helicopter Performance; Helicopter Control; Aerodynamic Stability; Helicopter Design

19970025412 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik, Brunswick, Germany

ONERA AND DLR COOPERATION ON THE SMART HELICOPTER CONCEPT: HANDLING QUALITIES DATA BASE FOR HOVER AND LOW SPEED FLIGHT

Bouwer, G., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Taghizad, A., Office National d'Etudes et de Recherches Aerospatiales, France; Moedden, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1997; 8p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The handling qualities of a helicopter in the hover / low speed range were investigated with a lateral tracking task. The desired behaviour of decoupled rate command / attitude hold and attitude command systems were programmed in conceptual models with numerous sets of bandwidth / phase delay configurations. In a first step, the task was flown in a fixed base simulator. Then selected configurations were investigated in flight on a helicopter in-flight simulator. In the ground simulator, the pilots clearly preferred attitude command systems. In the flight tests, none of the attitude command systems was rated Level 1. For rate command / attitude hold systems, the configurations were rated with Level 1 and Level 2 with a clear boundary at a bandwidth of 2.5 rad/sec.

Author

Helicopter Design; Helicopter Control; Attitude Control; Controllability; Flight Tests; Command Guidance; Roll; Data Bases

19970025413 National Defence Headquarters, Air Vehicles Research Sector, Ottawa, Ontario Canada

DEVELOPMENT OF A TACTICAL HELICOPTER INFRARED SIGNATURE SUPPRESSION (IRSS) SYSTEM

Sully, P. R., National Defence Headquarters, Canada; VanDam, D., Davis (W. R.) Engineering Ltd., Canada; Bird, J., Institute for Aerospace Research, Canada; Luisi, D., Department of National Defence, Canada; Apr. 1997; 12p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The world-wide availability of increasingly sophisticated but light weight infrared missile systems is presenting a serious threat to tactical helicopters in regional and peace-keeping operations. Part of the response to this threat lies in reducing as much as possible the infra-red signature of these helicopters. This paper briefly describes the nature of the threat presented by such missiles. The design and development of countermeasures in the form of IR suppression systems to reduce the engine exhaust produced signature is detailed. The results of experimental investigations and trials completed to date are described, along with the estimated potential for improving survivability. Future programmes and plans are summarized.

Author

Helicopter Design; Countermeasures; Infrared Signatures; Infrared Suppression; Missiles; Aircraft Detection; Jet Exhaust

19970025414 Textron Bell Helicopter, Mirabel, Quebec Canada

MODEL 412 COMPOSITE TAILBOOM

Mussett, G., Textron Bell Helicopter, Canada; Fews, R., Textron Bell Helicopter, Canada; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Bell Helicopter Textron is developing a technology demonstrator in the form of a Composite Tailboom for the Model 412 and 212 helicopters, to potentially replace the existing metallic design. The composite tailboom has been designed for producibility and low cost whilst maintaining the capability to withstand the operating environment of the Model 412 and 212 helicopters. During the development of the tailboom, concurrent engineering philosophies were used so that manufacturing and tooling considerations were recognized in the design concept stage resulting in a very economical and producible design. Additionally the composite tailboom has been designed for fatigue with a high degree of redundancy in critical areas making it very tolerant to in service damage.This has been proven by an extensive material qualification and structural test program at Bell Helicopter. The composite tailboom is scheduled for flight test and FAA certification in 1996.

Author

Bell Aircraft; Helicopters; Manufacturing; Helicopter Design; Flight Tests; Composite Materials; Aircraft Construction Materials; Tail Assemblies

19970025415 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Structures and Design, Stuttgart, Germany

CRASH RESISTANT COMPOSITE SUBFLOOR STRUCTURES FOR HELICOPTERS

Johnson, A. F., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Kindevater, C. M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Thuis, H. G. S. J., National Aerospace Lab., Netherlands; Wiggenraad, J. F. M., National Aerospace Lab., Netherlands; Apr. 1997; 12p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The paper describes the application of composite materials to the design of crash resistant beam and frame elements for helicopter subfloor structures, and discusses alternative fabrication technologies for these structural elements. These elements require a dual function structural concept with load carrying capability under flight loads and energy absorption under crash loads. The realization of this dual function by innovative design with fibre reinforced composite materials is described. In order to utilize these lightweight structural concepts in helicopters, cost effective technologies for series production of composite components are required. The paper discusses three fabrication methods based on autoclave technology, resin transfer moulding (RTM) and thermoforming, taking a sine-wave floor beam as a demonstrator component for the technologies.

Author

Fiber Composites; Helicopter Design; Aircraft Structures; Structural Design; Composite Structures; Resin Transfer Molding; Crashworthiness; Fabrication; Aircraft Construction Materials; Floors

19970025416 Lockheed Martin Corp., Electronics and Missiles, Orlando, FL United States

INTRODUCTION OF BERYLLIUM ALUMINUM CASTINGS IN THE RAH-66 COMANCHE EOSS PROGRAM

Seinberg, J. P., Lockheed Martin Corp., USA; Tetz, D. P., Lockheed Martin Corp., USA; Raftery, K. R., Nuclear Metals, Inc., USA; Apr. 1997; 12p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Beryllium aluminum alloys, containing greater than 60 weight percent beryllium, are very attractive materials for lightweight and high-stiffness applications. However, due to the inherent problems associated with casting these alloys, processing of beryllium aluminum has generally been restricted to rolling and extrusion of prealloyed powder metal compacts. Nuclear Metals, Inc. (NMI), with technical and financial support from the Lockheed Martin Electronics and Missiles (LMEM) RAH-66 Comanche Electro-Optical Sensor System (EOSS) program, has recently developed a family of castable beryllium aluminum alloys suited for production using state-of-the-technology investment casting processes. These new alloys, identified as Beralcast(R), yield a fine grain homogenous microstructure with attractive mechanical, physical and thermal properties. The problems associated with producing beryllium aluminum castings, including molten metal reactivity and a wide solidification range, have been resolved by NMI and LMEM. As a result of the efforts to date, over fifty different Comanche EOSS components of various sizes and complexities will be produced using Beralcast(R) alloys. In certain cases, where designs are being modified to take full advantage of the Beralcast(R) properties, component weight savings of up to 50% over conventional materials can be achieved. Current focus is on the optimization of both casting and associated secondary support

processes, material characterization, non-destructive testing, and cost reduction. Developmental program goals, over the next eighteen months, being addressed in a series of programs funded by NMI, LMEM and the Army Aviation Research and Development Center, will provide the technology for the fabrication of large, complex precision investment castings. As a result of these efforts, Beralcast(R) investment castings will be available in time to support the RAH-66 Comanche EOSS demonstration/validation (Dem/Val) flight hardware program.
Author
Beryllium Alloys; Aluminum Alloys; Casting; Fabrication; Helicopter Design; Aircraft Construction Materials; Metal Powder; Optical Measuring Instruments; Mechanical Properties; Helicopters

19970025418 Textron Bell Helicopter, Fort Worth, TX United States
DUCTED TAIL ROTOR DESIGNS FOR ROTORCRAFT AND THEIR LOW NOISE FEATURES
Edwards, Bryan, Textron Bell Helicopter, USA; Andrews, Jim, Textron Bell Helicopter, USA; Rahnke, Chris, Textron Bell Helicopter, USA; Apr. 1997; 16p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

During the development of an advanced ducted tail rotor (DTR) design, a concentrated and successful effort was made to research and incorporate the low noise features of a DTR suitable for intermediate size rotorcraft. The design, whirl stand testing, and flight evaluations of this DTR configuration are described. Results of noise testing are presented for multiple design configurations to study the parametric effects of blade spacing, tip shape, rotational speed, and inflow turbulence. The acoustic effects of each parameter are presented, and measured noise reductions are identified. Isolated model ducted-rotor configurations are described, leading to additive noise level reductions of more than ten decibels for the DTR design. Installed on a Bell Model 222U helicopter, the DTR reduces total noise during hover and forward flight by an average of 2 to 6 dBA compared to the Model 222U configured with a standard tail rotor. A dramatic improvement in sound quality was found in subjective comparison tests. The performance and handling qualities of the test helicopter with the DTR prove to be similar to those characterizing a standard tail rotor. Component loads are well within design limits. These design qualities are discussed and substantiating test data are presented.
Author
Helicopter Design; Rotary Wing Aircraft; Tail Rotors; Noise Reduction; Flight Tests; Bell Aircraft; Ducted Bodies; Structural Design

19970025419 Office National d'Etudes et de Recherches Aerospatiales, Direction des Structures, Paris, France
IN-FLIGHT MEASUREMENTS AND PREDICTION OF INTERNAL NOISE OF ECUREUIL HELICOPTER *MESURES EN VOL ET PREVISION DU BRUIT INTERNE D'UN HELICOPTERE ECUREUIL*
Morvan, A., Office National d'Etudes et de Recherches Aerospatiales, France; David, J.-M., Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1997; 8p; In French; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In order to characterize the potential sources of noise in a helicopter cabin and to validate a model of the cabin based on the SEA (Statistical Energy Analysis) method used as a predictive method, measurements were made by the ONERA Structures Department vibroacoustical team at EUROCOPTER FRANCE in Marignane while the SEA modeling was being carried out. Experimental equipment used in the single-engine helicopter ECUREUIL, data recording and analysis procedures are described and results are analyzed for different flight speeds. The SEA model of helicopter cabin is then presented and the way to take into account the different sources of excitation in this model. A model of aerodynamic excitation (due to turbulent boundary layer) is based on a simplified numerical approach. Finally, a comparison between measurements and computation for vibration response of structural parts and acoustical pressure in the cabin is presented.
Author
Helicopter Design; Noise Reduction; Aircraft Compartments; Aircraft Models; Noise Prediction (Aircraft); Flight Tests; Structural Vibration; Statistical Analysis

19970025420 Technische Hogeschool, Faculty of Aerospace Engineering, Delft, Netherlands
UPGRADING OF CLASSICAL LIFTING-LINE THEORY TO OBTAIN ACCURATE FLIGHT MECHANICAL HELICOPTER MODELS: IMPROVED CORRECTION FOR SWEEP EFFECTS
vanHolten, T., Technische Hogeschool, Netherlands; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In the usual analysis of the helicopter rotor, models and concepts are used which originate from classical lifting line theory. A theory, strictly valid for the analysis of straight high aspect ratio wings in steady flow. In the case of a helicopter rotor blade, the validity of these models is questionable since its sections encounter unsteady and yawed flow. Asymptotic theory shows how in this case more correct models may be synthesized. The present paper deals with an improved correction for the effect of sweep on the tilt of the rotor's tip path plane. Its application to a simple test case shows that the prediction of its lateral tilt is considerably affected. The new model for sweep effects might thus explain the often observed peak of the lateral tilt at small flight velocities.
Author
Helicopters; Rotors; Rotary Wings; Sweep Effect; Unsteady Flow; Rotor Blades; Rotor Aerodynamics; Asymptotic Series; Helicopter Design

19970025422 Army Aviation Systems Command, Aeroflightdynamics Directorate, Moffett Field, CA United States
AN EMPIRICAL CORRECTION METHOD FOR IMPROVING OFF-AXES RESPONSE PREDICTION IN COMPONENT TYPE FLIGHT MECHANICS HELICOPTER MODELS
Mansur, M. Hossein, Army Aviation Systems Command, USA; Tischler, Mark B., Army Aviation Systems Command, USA; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Historically, component-type flight mechanics simulation models of helicopters have been unable to satisfactorily predict the roll response to pitch stick input and the pitch response to roll stick input off-axes responses. In the study presented here, simple first-order low-pass filtering of the elemental lift and drag forces was considered as a means of improving the correlation. The method was applied to a blade-element model of the AH-64 Apache, and responses of the modified model were compared with flight data in hover and forward flight. Results indicate that significant improvement in the off-axes responses can be achieved in hover. In forward flight, however, the best correlation in the longitudinal and lateral off-axes responses required different values of the filter time constant for each axis. A compromise value was selected and was shown to result in good overall improvement in the off-axes responses. The paper describes both the method and the model used for its implementation, and presents results obtained at hover and in forward flight.
Author
AH-64 Helicopter; Aerodynamic Drag; Helicopter Control; Aircraft Models; Helicopter Design; Flight Control; Aerodynamics; Lift

19970025423 Politecnico di Torino, Dipt. di Ingegneria Aeronautica e Spaziale, Torino, Italy
EFFECT OF PROPULSION SYSTEM DYNAMICS ON ROTORCRAFT AEROMECHANICAL STABILITY IN STRAIGHT AND TURNING FLIGHT
Guglieri, Giorgio, Politecnico di Torino, Italy; Celi, Roberto, Maryland Univ., USA; Quagliotti, Fulvia, Politecnico di Torino, Italy; Apr. 1997; 8p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In recent years there has been growing interest in improving the fidelity of mathematical models of helicopter fight dynamics through a more accurate representation of the main rotor dynamics. The main objective of this paper is to study the effect of several parameters of the propulsion system on the aeromechanical characteristics of a hingeless rotor helicopter, both in straight flight and in coordinated turns. The effects of these parameters on the handling qualities of the aircraft will also be examined (pitch and roll frequency response).
Author
Propulsion; Propulsion System Performance; Rotary Wing Aircraft

19970025424 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Design Aerodynamics, Brunswick, Germany
AERODYNAMIC AND ACOUSTICS OF ROTORCRAFT: A SURVEY OF THE 75TH FLUID DYNAMICS PANEL SYMPOSIUM, BERLIN
Koerner, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Pahlke, K., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1997; 18p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A survey of the 75th Fluid Dynamics Panel Symposium is given. The paper concentrates on dynamic stall, experimental investigations on helicopter rotors, 3D aerodynamic prediction methods and acoustic prediction methods. CFD methods were applied to dynamic stall on oscillating airfoils. The agreement with experimental data is acceptable for light and medium stall if appropriate turbulence models are used and the transition is fixed. None of the methods was able to accurately predict deep dynamic stall. A large effort was spent for the investigation of the Blade Vortex Interaction (BVI) noise. New national and multi-national experimental campaigns were conducted. Several researchers worked on the development and validation of aerodynamic and acoustic prediction methods for BVI. The efficiency of Higher Harmonic Control and of Individual Blade Control inputs for the reduction of BVI noise were investigated. The blade vortex miss distance was found to be the most important parameter for BVI noise. Methods for the prediction of high speed impulsive noise have been developed and encouraging results were presented.
Author
Rotary Wing Aircraft; Acoustics; Aerodynamic Stalling; Conferences

19970025425 Westland Helicopters Ltd., Yeovil, United Kingdom
THE INTEGRATED DEVELOPMENT OF A MEDIUM LIFT MILITARY/CIVIL HELICOPTER
Graham, J. P., Westland Helicopters Ltd., UK; Apr. 1997; 12p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The EH industries EH101 medium sized rotorcraft is the first of its kind to achieve production status that has been designed from the outset as a vehicle able to meet, without significant compromise, all appropriate civil and military regulatory requirements. Now that the design and development programme is nearing completion it is an appropriate time to review the success of the joint civil/military programme strategies which were implemented by EH Industries from the outset and which have significantly shaped both the product of the programme (EH101) and the programme design process.
Author
Product Development; Military Helicopters

19970025426 Westland Helicopters Ltd., Advanced Projects Dept., Yeovil, United Kingdom
COMPOUND INTEREST: A DIVIDEND FOR THE FUTURE?
Humpherson, D. V., Westland Helicopters Ltd., UK; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper seeks to explore the application of thrust and lift compounding as a cost efficient development of the traditional helicopter. The principal deficiencies of the edgewise rotor are examined and the use of compounding to overcome these limitations and enhance rotorcraft capabilities, is developed. Potential missions suitable for the various types of compounding and the concept of a family of vehicles to cover a wide variety of applications are discussed. A possible technology demonstrator, based on a Lynx airframe and its build standard are described. Finally a list of overall conclusions are drawn.
Author
Rotary Wing Aircraft; Costs; Airframes; Product Development

19970025427 Sikorsky Aircraft, Trumbull, CT United States
RAH-66 COMANCHE PROGRAM STATUS
Linden, Arthur W., Sikorsky Aircraft, USA; Stieglitz, Martin H., Sikorsky Aircraft, USA; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In an era of ever changing threats and declining defense budgets, the U.S. Army strategy is to procure systems that incorporate new technology and that leverage existing battlefield systems to fix war fighting deficiencies. The RAH-66 Comanche exemplifies this strategy. Developed through an evolutionary series of analyses, simulations, tests and demonstrations, the Comanche weapon system integrates war fighting capability to provide battlefield overmatch, while minimizing the cost of ownership to the Army. Comanche is an integrated advanced weapons system designed to operate and survive on the combined arms digital battlefield. Its Low-Observable (LO) characteristics protect the element of surprise and reduce the detectability of the aircraft, thus increasing survivability. Comanche's advanced sensor suite provides the aircraft effective standoff while allowing it to remain undetected by the enemy and still operate within onboard armament system range. This capability allows the pilot to correctly identify targets and can effectively reduce fratricide under nonlinear operations. The Comanche's advanced digital communication system makes Comanche the targeting element for the Army's long-range advanced shooters like the Multiple Launch Rocket System (MLRS) and the Army Tactical Missile System (ATACMS). This paper provides an update to the development status of the RAH-66 Comanche helicopter. Section 2 reviews key technologies that form the heart of Comanche. Section 3 explains the Comanche design affords rapid deployability and low-cost supportability. The extensive use of simulation throughout Comanche development is described in Section 4. The success of the Comanche program rests in large part on the successful taswork that is integral to all program activities. Section 5 explains the Team Comanche approach. Finally, Section 6 describes the plan to field the Army's 21st century reconnaissance attack helicopter in 2006.
Author
Helicopters; Helicopter Performance; Design Analysis; Product Development; Low Cost

19970025429 Boeing Defense and Space Group, Helicopter Div., Philadelphia, PA United States
V-22 TECHNICAL CHALLENGES
Glusman, Steven I., Boeing Defense and Space Group, USA; Hyland, Robert A., Boeing Defense and Space Group, USA; Marr, Roger L., ITT Corp., USA; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Bell-Boeing V-22 Osprey Tiltrotor is an unique aircraft capable of landing vertically like a helicopter, flying at speeds in excess of 300 KTAS like a turboprop, with the added feature of folding the rotor/wing for deployment from shipboard for US Navy/Marines operations. During the development of the V-22 and subsequent 1000+ hours of flight testing, many technical challenges were encountered and overcome. These challenges included aerodynamic characteristics of the wing, tail buffet, hover performance, hover downwash, structural loads limiting, vibration reduction, landing gear fatigue life, and control law design/Handling Qualities. This paper presents an overview of many of these challenges, discusses the techniques used to perform analysis and fight test, and presents results of the relevant portions of the test program.
Author
V-22 Aircraft; Aerodynamic Characteristics; Fatigue Life; Flight Tests

19970025430 Institute for Aerospace Research, Flight Research Lab., Ottawa, Ontario Canada
COCKPIT TECHNOLOGIES RESEARCH AT THE FLIGHT RESEARCH LABORATORY OF THE NATIONAL RESEARCH COUNCIL OF CANADA
Morgan, J. Murray, Institute for Aerospace Research, Canada; Baillie, Stewart W., Institute for Aerospace Research, Canada; Apr. 1997; 8p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Flight Research Laboratory of the Institute for Aerospace Research (FRL) has been involved, under the advice and with the support of the Department of Defence Chief of Research and Development, in examining the use of current and emerging technologies in the helicopter cockpit, and examinations of how these can be used to reduce pilot workload or improve situational awareness for the crew. This paper will describe work at the pilot/machine interface, rather than manipulation of the machine itself. Three on-going segments of this program will be described, Direct Voice Input, Helmet Mounted Displays and advanced Head Down Displays.
Author
Helicopters; Cockpits; Helmet Mounted Displays; Head-Up Displays

19970025434 Auburn Univ., Adaptive Aerostructures Lab., AL United States
THE SOLID STATE ADAPTIVE ROTOR: DESIGN, DEVELOPMENT AND IMPLICATIONS FOR FUTURE ROTORCRAFT
Barrett, Ron, Auburn Univ., USA; Stutts, James, Auburn Univ., USA; Apr. 1997; 8p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In recent years, numerous studies have been centered on a novel class of materials which are capable of changing their shapes, imparting forces and generating moments as a function of applied electrical signals. This study is centered on one application of these 'adaptive' materials to achieve rotor flight control. A pair of twist-active directionally attached piezoelectric (DAP) torque-plates constructed from PZT-5H piezoceramic sheets laid up on an aluminum substrate were bonded rigidly to a rotor shaft.
Derived from text
Solid State; Rotors; Rotary Wing Aircraft; Piezoelectricity; Piezoelectric Ceramics

19970026152 Boeing Sikorsky Joint Program Office, Philadelphia, PA United States
PERFORMANCE
Harper, William H., Boeing Sikorsky Joint Program Office, USA; Jul. 1997; 14p; In English; See also 19970026150; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Power margin is a standard measure of helicopter performance. However, in the competitive market place of today, performance is also an economic measure--cost to operate. Engine technology has significantly reduced fuel consumption and advances in composite technologies have produced lightweight structures. External weapons increase an armed helicopters parasite drag by 40% to 50%. Drag reduction is, therefore, the next largest contribution to fuel savings with figure-of-merit and rotor lift/effective drag ratio improvement the next two important areas. This paper explores the advances made in rotor blade design technologies following the UH-60 and Apache. The performance of an advanced airfoil rotor design is compared to the UH-60 and other existing helicopters to quantify the advancements. The methodology and analytical tools used to predict the performance of the advanced airfoil rotor is completely described. The resulting rotor system is then used to examine a number of options selected to reduce the drag contribution of external stores.
Derived from text
Helicopter Performance; Lift Drag Ratio; Rotor Lift; Airfoils

19970026153 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik, Brunswick, Germany
HANDLING QUALITIES
Gmelin, Bernd L., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Jul. 1997; 22p; In English; See also 19970026150; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The mission performance of an armed helicopter does not only depend on its weapon system's efficiency. Other factors like the helicopter performance and in particular the handling qualities of the overall helicopter/weapon system may significantly affect mission performance. Since handling qualities cover a wide range of aspects which sometimes are difficult to quantify, it is useful to refer to existing standards when defining armed helicopters specifications.
Derived from text
Helicopter Performance; Controllability; Maneuverability; Flight Characteristics; Helicopters

19970026155 Eurocopter Deutschland G.m.b.H., Technical Group TIGER, Munich, Germany
LOADS, DYNAMICS/VIBRATIONS, ACOUSTICS
Wennekers, R., Eurocopter Deutschland G.m.b.H., Germany; Jul. 1997; 40p; In English; See also 19970026150; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Loads, dynamics/vibrations mechanics and acoustics are on one side classical disciplines which contribute to the integral helicopter layout. However in the context of weapon system integration they are the key areas where direct interfacing problems may arise between the basic helicopter and e.g. an external weapon store or a sight system.
Derived from text
Helicopters; Helicopter Performance; Vibration; Systems Integration; Loads (Forces); Acoustics

19970026156 McDonnell-Douglas Helicopter Co., Mesa, AZ United States
THE AH-64D APACHE LONGBOW WEAPONS SYSTEM
Dimmery, Hugh M., McDonnell-Douglas Helicopter Co., USA; Jul. 1997; 10p; In English; See also 19970026150; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The AH-64D Apache Longbow represents a significant enhancement in the evolution of attack helicopters. It is a fourth-generation precision weapon system that is totally integrated. The high level of integration provides an efficient and operationally effective system and gives commanders at all levels the ability to meet modern battlefield requirements ranging from peacekeeping to major regional conflict. This paper examines some of the AH-64D Apache Longbow capabilities, its inherent design features that maximize performance and provides a summary of the demonstrated level of performance.
Author
Military Helicopters; Weapon Systems; AH-64 Helicopter

19970026157 Boeing Sikorsky Joint Program Office, Philadelphia, PA United States
RAH-66 COMANCHE CASE HISTORY
Harper, William H., Boeing Sikorsky Joint Program Office, USA; Jul. 1997; 24p; In English; See also 19970026150; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Combat helicopters perform two basic missions: attack and reconnaissance. The mobility, situational awareness, and firepower that combat helicopters provide ground forces was well demonstrated during the Vietnam War. Operation Desert Storm provided a glimpse of modern nonlinear, close combat, coalition warfare and reinforced the importance of advanced technology combat equipment.
Derived from text
Helicopters; Reconnaissance; Combat; Ground Resonance; Military Helicopters

19970026158 Westland Helicopters Ltd., Yeovil, United Kingdom
EH101
McBeath, J. R. B., Westland Helicopters Ltd., UK; Jul. 1997; 14p; In English; See also 19970026150; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The EH101 is a family of naval, utility and civil helicopters whose design and development have benefited from the different requirements of each of these operating regimes. The paper examines weapon integration on the EH101, focusing on the overall weapon system of which the helicopter is a major component. While the details provided are in most instances generic to all naval EH101 variants, specific details of the Royal Navy's Merlin HM Mk.1 helicopter are given where appropriate. The paper also outlines the highly complex contractual structures that lie behind the Merlin HM Mk.1 program. The paper concludes with a number of lessons that should be of advantage to future weapon integration programs.
Derived from text
Helicopters; Helicopter Control; Helicopter Performance

19970026159 Eurocopter Deutschland G.m.b.H., Munich, Germany
TIGER
Wennekers, R., Eurocopter Deutschland G.m.b.H., Germany; Jul. 1997; 26p; In English; See also 19970026150; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The development of the TIGER helicopter/weapon system is a joint effort at equal parts of Germany and France to meet the requirements for combat support, air-to-air protection, escort, reconnaissance and anti-tank helicopter missions in post cold-war conflict scenarios. From a basic helicopter and avionics system the following versions are derived.
Derived from text
Helicopters; Reconnaissance; Combat; Avionics

19970029335 Dassault Aviation, Direction Generale Technique, Saint-Cloud, France
EVOLUTION OF PHILOSOPHY OF DESIGN LOADS FOR MILITARY AIRCRAFT *EVOLUTION DE LA PHILOSOPHIE DES CHARGES DE DIMENSIONNEMENT DES AVIONS MILITAIRES*
Petiau, C., Dassault Aviation, France; Loads and Requirements for Military Aircraft; Feb. 1997; 8p; In French; See also 19970029334; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

After a brief recall of the principles of design load definition resulting from classical regulations, we show the difficulties of their application for combat aircraft equipped with Electrical Flight Control System (E.F.C.S.). This has led to an integrated process, where definition of design loads and setting of E.F.C.S. has been coupled, aiming finally to guarantee keeping the aircraft within a limit strength domain. This evolution reinforces the definition principle of limit loads as maximum loads to be expected in service, yet, without need for links with regulation standard maneuvers. We present the main aspects of this process, which includes: the definition of load severity indicators, and the elaboration of corresponding calculation operators; systematic calculations of these indicators during flight mechanics simulations (including real time development flight simulators); use of mathematical optimization techniques, allowing to handle exchange rate between maneuver performances and structural sizing. For general cases it is not proven that these evolutions could justify a modification of ultimate loads/limit loads safety factors.
Author
Flight Control; Loads (Forces); Systems Engineering; Design Analysis; Military Aircraft; Structural Design; Flight Load Recorders

19970029336 NASA Lewis Research Center, Cleveland, OH United States
PROBABILISTIC APPROACHES: COMPOSITE DESIGN
Chamis, Christos C., NASA Lewis Research Center, USA; Loads and Requirements for Military Aircraft; Feb. 1997; 14p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Probabilistic composite design is described in terms of a computational simulation. This simulation tracks probabilistically the composite design evolution from constituent materials, fabrication process through composite mechanics, and structural component. Comparisons with experimental data are provided to illustrate selection of probabilistic design allowables, test methods/specimen guidelines, and identification of in situ versus pristine strength. For example, results show that: in situ fiber tensile strength is 90 percent of its pristine strength; flat-wise long-tapered specimens are most suitable for setting ply tensile strength allowables; a composite radome can be designed with a reliability of 0.999999; and laminate fatigue exhibits wide spread scatter at 90 percent cyclic-stress to static-strength ratios.
Author
Structural Design; Composite Structures; Fabrication; Reliability Analysis; Computer Programs; Design Analysis; Graphite-Epoxy Composites; Structural Analysis; Structural Design Criteria; Laminates

19970029337 Daimler-Benz Aerospace A.G., Bremen, Germany
DETERMINATION AND VERIFICATION OF OPERATIONAL MANEUVER PARAMETERS AND TIME HISTORIES
Molkenthin, J., Daimler-Benz Aerospace A.G., Germany; Feb. 1997; 16p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper describes a procedure for the evaluation of operational maneuver parameters and time histories, with the goal, to derive loads from operational flight parameters. The basic assumption is that for each operational maneuver type performed, in service or simulation as a set of normalized parameter time histories can be verified, and are called Standard Maneuvers. The Standard Maneuver is obtained by normalization of amplitudes and maneuver time to make the parameters independent of intensity of the maneuver, flight condition, flight control system, mass configurations, and the aircraft type. This paper outlines the determination of the operational maneuver parameters, the identification process of the maneuver types, the normalization procedure, the determination and verification of the Standard Maneuver time histories.
Author
Aerodynamic Loads; Flight Control; Design Analysis; Structural Design Criteria; Systems Engineering; Aircraft Maneuvers; Structural Design

19970029338 Daimler-Benz Aerospace A.G., Bremen, Germany
FLIGHT LOADS DERIVED FROM OPERATIONAL MANEUVERS
Struck, H., Daimler-Benz Aerospace A.G., Germany; Perron, C., Bombardier, Inc., Canada; Feb. 1997; 16p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper describes the feasibility for the determination of operational loads applying an operational Maneuver Model. The essential input for the Maneuver Model is a set of Standard Maneuvers consisting of normalized operational parameter time histories. Operational external loads can be determined for: extreme operational loads, fatigue loads, and loads related to the operational parameters by introducing aircraft basic data, flight condition and boundary conditions for the maneuver to be considered. The application of the Maneuver Model is demonstrated for one aircraft. For some operational maneuvers the extreme operational loads are determined and compared with the design loads required by MIL-8861. The application of Standard Maneuver independent of the aircraft type has been demonstrated by determination of the loads applying the Standard Maneuver time histories from F-16 reconstituted to real time using the CF-18 performance data. The calculation of the loads has been performed using a proven Canadian loads calculation methodology and compared against flight test data of CF-18.
Author
Aerodynamic Loads; Flight Tests; Aircraft Maneuvers; Fighter Aircraft; Automatic Flight Control; Aircraft Design

19970029340 Daimler-Benz Aerospace A.G., Military Aircraft LMT2, Munich, Germany
THE IMPACT OF DYNAMIC LOADS ON THE DESIGN OF MILITARY AIRCRAFT
Luber, W., Daimler-Benz Aerospace A.G., Germany; Becker, J., Daimler-Benz Aerospace A.G., Germany; Sensburg, O., Daimler-Benz Aerospace A.G., Germany; Feb. 1997; 28p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The layout of military aircraft structures is strongly influenced by dynamic loads from the early development phase onwards up to final design and clearance phase. Different dynamic loads have to be considered, namely dynamic gust loads, buffet loads on wing, fin, fuselage and also buffet loads from airbrakes, cavities and blisters, gunfire loads mainly at attachment frames and panels, Hammershock loads for air intake, bird strike and ammunition impact, acoustic loads for outer air intake and missile bays. Also dynamic loads from landing, jettison, brake chute and rough runway induced loads as well as wake induced loads may be designed. Dynamic loads resulting from flight test excitation like bunker input, stick jerks and control surface sweeps also have to be considered. For some of the designing dynamic loads, examples are given to explain their derivation and significance both for design of aircraft structural parts and related clearance aspects. Methods to derive dynamic design loads for different applications by using analytical and experimental tools will be presented. Validation methods for various design loads using dynamic model test results, wind tunnel model and flight test results are mentioned. The main purpose of this presentation is to indicate where dynamic loads would be dimensioning structures of future high performance combat airplanes and how to approach the problem of integrating all aspects into an optimum design.
Author
Aircraft Design; Aircraft Structures; Buffeting; Dynamic Loads; Flight Tests; Structural Design; Military Aircraft; Gust Loads; Structural Design Criteria

19970029341 British Aerospace Defence Ltd., Aerodynamics Dept., Preston, United Kingdom
DYNAMIC LOADING CONSIDERATIONS IN DESIGN OF MODERN COMBAT AIRCRAFT
Chapman, R., British Aerospace Defence Ltd., UK; Feb. 1997; 16p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The design and clearance for flight of recent aircraft has provided new challenges in the field of loads prediction and validation. Traditionally during the initial design phases of an aircraft project, dynamic loading effects have been covered by uncertainty tolerances applied to static loads. Only when structural or equipment qualification problems emerge during development testing, or worse in-service, have dynamic loading problems been fully addressed. The approach at BAe is to include dynamic loading at the design and development stage to a much greater extent than formerly. This is with the intention of reducing or eliminating the need for costly post-design investigations and/or structural redesign. This paper outlines the effects considered and some examples of the challenges encountered with respect to

project constraints/criteria, methods maturity and flight clearance procedures. As validation of dynamic loading predictions is essential to aircraft qualification and certification, examples comparing predicted and flight measured data are presented.
Author
Aircraft Design; Fighter Aircraft; Dynamic Loads; Structural Design; Aircraft Structures; Aerodynamic Loads; Design Analysis

19970029342 Aerospatiale, Toulouse, France
THE GROUND LOADS DURING PHASES OF ROLLING: THE CIVILIAN AND MILITARY SPECIFICATIONS *LES CHARGES AU SOL LORS DES PHASES DE ROULAGE: LES SPECIFICATIONS CIVILES ET MILITAIRES*
Sqeglia, G., Aerospatiale, France; Regis, O., Aerospatiale, France; Feb. 1997; 13p; In French; See also 19970029334; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche .

This article presents a comparative study of American, English, and French standards and civil specifications (JAR/FAR) applied to conditions of ground roll. The results obtained with small bumps, the actual surfaces, and the work accomplished within the framework of civil regulations are presented. The influence of these different regulations is explained in taking for example a civilian turboprop certified for operations on semi-prepared surfaces.
Transl. by SCITRAN
Aircraft Design; Loads (Forces); Aircraft Specifications; Ground Tests; Aircraft Structures; Roll

19970029343 Lockheed Martin Tactical Aircraft Systems, Weapons System Design Center, Fort Worth, TX United States
EVOLUTION OF F-16 LOADS AND REQUIREMENTS
Gibson, David H., Lockheed Martin Tactical Aircraft Systems, USA; Feb. 1997; 12p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This article presents a review of the historical background of the growth of external loads and design requirements for the F-16 fighter aircraft. Several scenarios are recounted where analysis assumptions were determined to be inadequate and flight test or operational data presented situations not fully covered by design criteria. Changes in design requirements are discussed and suggestions for future aircraft design analyses are offered.
Author
Aircraft Design; F-16 Aircraft; Design Analysis; Flight Tests; Loads (Forces); Structural Design; Aircraft Structures

19970029345 Daimler-Benz Aerospace A.G., Munich, Germany
INFLUENCE OF THRUST VECTORING SYSTEM (TVS) ON STRUCTURAL DESIGN LOADS
Fuelhas, Konrad, Daimler-Benz Aerospace A.G., Germany; Neubauer, Martin, Daimler-Benz Aerospace A.G., Germany; Feb. 1997; 12p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The maneuverability and performance of modern fighter aircraft can be enhanced by a Thrust Vectoring System (TVS). This paper will show the benefits for the aircraft (e.g. Poststall) and identify the change in the structural design loads when a TVS will be adapted to an existing fighter aircraft. The requirement is to minimize structural changes under consideration of the benefits from the TVS for aircraft and performance. The capabilities and properties of new fighter aircraft to be designed initially including TVS will be touched on.
Author
Aircraft Design; Thrust Vector Control; Structural Design; Loads (Forces); Fighter Aircraft; Thrust; Maneuverability; Aircraft Performance

19970029346 British Aerospace Defence Ltd., Aerodynamics Dept., Preston, United Kingdom
EUROFIGHTER 2000 STRUCTURAL DESIGN CRITERIA AND DESIGN LOADING ASSUMPTIONS
Watson, G. J., British Aerospace Defence Ltd., UK; Feb. 1997; 10p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper provides an overview of the assumptions employed in the preparation of Design Loads for the Eurofighter 2000 aircraft. For loading purposes, a set of Design Criteria have been defined, which summarize the principal maneuver requirements for the aircraft. Additional assumptions on aircraft Control usage have been necessary to allow Design Loads to be defined without a detailed knowledge of the final standard of Flight Control System. The assumptions employed have been aimed at providing a robust structural design for the airframe, an aim which is now being validated through the Flight Clearance and Test activities on which the first Prototype aircraft are currently engaged.
Author
Aircraft Control; Structural Design Criteria; Aircraft Design; Aircraft Structures; Aircraft Maneuvers; Flight Control; Structural Design; Loads (Forces); Fighter Aircraft

19970029350 Lockheed Martin Tactical Defense Systems, Saint Paul, MN United States
COTS JOINS THE MILITARY
Anderson, L., Lockheed Martin Tactical Defense Systems, USA; Stevens, R., Lockheed Martin Tactical Defense Systems, USA; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The complexity of today's military system has caused the priority of affordability to rise to an unprecedented level among system requirements. An increasing number of government and defense industry leaders are relying on commercial off-the-shelf (COTS) products with the associated economies of scale and use of non-developmental items (NDI) to meet this requirement. The affordability benefits of COTS and NDI for military systems are subject to several other factors. For example, as the need for products capable of operating in a hostile military environment increases, the number of products and vendors meeting these requirements decreases. In addition, military systems, which traditionally have been expected to survive for long periods of time, are subjected to two commercial phenomena that occur simultaneously - product prices decrease over time while technology provides an increase in product performance. The latter factor results in a dichotomy summarized as parts obsolescence. This paper identifies additional military system issues and current commercial trends and postulates how these trends can be used to meet affordability requirements. The latter includes illustrated use of open system standards combined with pre-planned product improvement (P3I).
Author
Defense Industry; Dichotomies; Economy

19970041535 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
AGING COMBAT AIRCRAFT FLEETS: LONG TERM APPLICATIONS *LES CONSEQUENCES A LONG TERME DU VIEILLISSEMENT DES FLOTTES D'AVIONS DE COMBAT*
Oct. 1996; 236p; In English; Aging Combat Aircraft Fleets: Long Term Applications, 7-8 Oct. 1996, Madrid, Pomezia, Atlanta, GA, Brussels, Spain, Italy, USA, Belgium; See also 19970041536 through 19970041547
Report No.(s): AGARD-LS-206; ISBN 92-836-1044-X; Copyright Waived; Avail: CASI; A11, Hardcopy; A03, Microfiche

This Lecture Series covers systems update and structural airworthiness aspects of aging, fixed-wing aircraft. It highlights the aspect of retrofit/rejuvenation of aging aircraft through presentations relating to three front-line combat aircraft in NATO's inventory. The presentations describe the implementation strategies and ways to improve the ability of an airframe to accommodate new systems to meet present day mission requirements. Technical issues pertaining to structural safety, maintenance management, and proactive rehabilitation/retrofit schemes are also discussed. It provides technical information to fleet operators and managers to assist them to better manage aging aircraft fleets and be able to deal with aging related problems as they arise. It also targets industry personnel responsible for upgrading the capabilities of combat aircraft, maintenance personnel at air logistics centers, and specialists involved with the design of repairs and prescription of inspection methods. "Aging aircraft" has several connotations, amongst them technological obsolescence, performance upgrading, changing mission requirements unanticipated

during design specification and development, the specter of runaway maintenance costs, decreased safety, impairment of fleet readiness, and unavailability of home depot facilities.
Author
Aging (Materials); Fighter Aircraft; Airframes; Safety Management; Aircraft Maintenance; Aircraft Reliability; Lectures; Specifications; Mission Planning; Aircraft Configurations

19970041536 Wright Lab., Wright-Patterson AFB, OH United States
USAF AGING AIRCRAFT PROGRAM
Rudd, James L., Wright Lab., USA; Aging Combat Aircraft Fleets: Long Term Applications; Oct. 1996; 14p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The USA Air Force (USAF) has numerous aircraft that have already met or exceeded their original design service lives; many of these aircraft will considerably exceed their original life goals before they are retired from the inventory. Technologies are needed which will extend the lives and/or reduce the costs of these aging aircraft. Such technologies will insure flight safety, reduce maintenance and repair requirements and their associated costs, and increase operational readiness. A description of the USAF aging aircraft systems research and development efforts that are being conducted in the technology categories of Structural Integrity, Nondestructive Evaluation/Inspection, Avionics, Propulsion and Subsystems is presented. The structural integrity area considers damage that can degrade the service lives of aging aircraft; the technologies required to ensure aircraft structural integrity with such damage present are identified. Typical types of damage considered include corrosion, fatigue cracking, and the potential interaction of corrosion and fatigue. Also, the possible occurrence of widespread fatigue damage (WFD), which becomes more likely as aircraft structure ages, is addressed. Life extension methodology is described that includes the development of analytical and experimental procedures for the repair (e.g., composite patches) of metallic structure that will restore or extend the full service life the damaged structure.
Derived from text
Aging (Materials); Aircraft Structures; Fatigue (Materials); Damage; Nondestructive Tests; Systems Engineering; Structural Failure; Service Life; Maintenance; Cost Reduction; Corrosion; Avionics

19970041537 Royal Air Force, Deputy Directorate Support Management Tornado (RAF), Huntingdon, United Kingdom
AGEING AIRCRAFT: MANAGING THE TORNADO FLEET
Marlow-Spalding, M. J., Royal Air Force, UK; Oct. 1996; 16p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

During the 1980's the RAF procured a fleet of 228 Strike/Attack and 170 Air Defense Tornado aircraft to form the back-bone of its long term fleet of combat aircraft. The Tornado aircraft was designed using 1970's technology, with a planned in-service life of 4000 flying hours and 100 Fatigue Index. The aircrafts original out of service date was 2003. Since then the primary use of the aircraft has changed to one of providing out of area support to United Nations and NATO operations. Furthermore, the aircraft's life has been extended so that it is now anticipated that the RAF will continue to fly the ADV until about 2010 and the IDS to approximately 2018, by which time the individual in-service aircraft will have accrued some 9000+ flying hours.To meet the challenge the RAF has had to address how the airworthiness of the airframe and flight safety critical components can be assured, whilst at the same time, ensuring that the aircraft continue to provide an operationally effective weapon platform at a time of unprecedented, technological advances.
Derived from text
Aging (Materials); Aircraft Reliability; Airframes; Fighter Aircraft; North Atlantic Treaty Organization (NATO); United Nations; Service Life

19970041538 National Research Council of Canada, Structures, Materials and Propulsion Lab., Ottawa, Ontario Canada
CANADIAN CF-18 STRUCTURAL LIFE MANAGEMENT PROGRAM
Simpson, D. L., National Research Council of Canada, Canada; Oct. 1996; 36p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Canadian Forces purchased 135 CF-18 A/B Hornet aircraft in the 1980's. Usage of the CF-18 in the Canadian role was and continues to be substantially different than that defined in the original design requirements. The early usage of the aircraft was very harsh in comparison to design and there were strong indications that airframes would have to be retired before reaching their design service life of 6000 hours. This situation required the adoption of a vigorous and proactive program to manage the structural life of the aircraft. This lecture describes the situation in some detail and then provides descriptions of the programs initiated to gain control over the operational usage and to develop the engineering data that will allow cost effective and safe operation of the aircraft to at least 6000 hours.
Author
F-18 Aircraft; Aging (Materials); Structural Engineering; Airframes; Cost Effectiveness; Aircraft Safety

19970041539 Aeronautical Systems Div., Wright-Patterson AFB, OH United States
F-16 SYSTEM/STRUCTURAL UPGRADES
DeFazio, Mark S., Aeronautical Systems Div., USA; Oct. 1996; 18p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Several systems upgrades have occurred throughout the life of the F-16 aircraft. This paper briefly discusses various system upgrades including navigational equipment, communication equipment, radar, stability and control, flight control system, and engines. The f-16 was originally designed to be a lightweight fighter with a service life of 8,000 flight hours. Due to the usage being more severe than design and an increase in weight, several structural modifications were necessary to keep the F-16C/D in service. The structural modification program known as "Falcon Up" is being accomplished by several countries for the F-16A/B/C/D aircraft. The program began in June 1993 for USAF and will complete around the year 2001. This paper discusses each of the structural problems and the modifications necessary to reach an 8,000 hour service life.
Derived from text
F-16 Aircraft; Structural Engineering; Upgrading; Communication Equipment; Radar; Flight Control; Navigation

19970041540 Oklahoma City Air Logistics Center, KC-135 System Program Office, Tinker AFB, OK United States
CORAL REACH: USAF KC-135 AGING AIRCRAFT PROGRAM
Davidson, Paul E., Oklahoma City Air Logistics Center, USA; Oct. 1996; 8p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper is intended to serve as an aid to any aircraft manager beginning to develop or expand an aging aircraft program. It is based on the experiences of the USAF KC-135 aircraft program since the early 1990's as they have fought to gain recognition and support for the issues faced by that program. CORAL REACH is a USAF program responsible for developing a GRAND STRATEGY for all age related issues on the C/KC-135 aircraft fleet. It is intended to ensure a logical, comprehensive and proactive program to sustain the aircraft until retirement. Today, the KC-135 aircraft have an average age of 38 years and many are expected to serve until the year 2040. Specific life extension efforts for the aircraft are dependent on the outcome of analyses and studies performed by the Integrated Product Team (IPT) incorporated under the CORAL REACH program. These analyses and studies focus on the technical, economic and safety aspect of the issues and become the basis for future actions to deal with the effects of an aging aircraft fleet.
Derived from text
Aging (Materials); C-135 Aircraft; Economic Factors; Service Life; Management Systems

19970041541 R-Tec, Rolling Hills Estates, CA United States
REPAIR/REFURBISHMENT OF MILITARY AIRCRAFT
Ratwani, Mohan M., R-Tec, USA; Oct. 1996; 22p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper discusses structural life enhancement through prestressing techniques such as cold working, shot peening, laser shock processing, etc. The state-of-practice methods of repairing metallic and composite structures are outlined. Advanced repair methods such as composite patch repair of of cracked metallic struc-

tures are shown. Finally, improved properties of advanced metallic materials are shown and their in-service applications to spare parts is discussed.
Derived from text
Aircraft Maintenance; Composite Structures; Prestressing; Shot Peening; Cold Working; Aging (Materials); Aircraft Structures

19970041542 Daimler-Benz Aerospace A.G., Military Aircraft, Munich, Germany
AIRCRAFT LOADS AND MONITORING
Neubauer, Martin, Daimler-Benz Aerospace A.G., Germany; Guenther, Georg, Daimler-Benz Aerospace A.G., Germany; Neunaber, R., Industrieanlagen-Betriebsgesellschaft m.b.H., Germany; Oct. 1996; 26p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The life of a weapon system is influenced to a high degree by the structural integrity of the airframe. Numerous programs to insure this have been established within NATO's Air Forces. Structural loads, leading to fatigue as well as corrosion, depending on the usage environment, are the major reason for the degradation of structures. The many different classes of loads, the generation of loading conditions during the design phase, consideration of static and fatigue loads for structural lay-out and their validation are presented. The fatigue life of aircrafts in service is different from the design life for many aircrafts not only due to the extended need for the airframe as a platform for new/upgraded systems (life extension), but also due to different usage compared to the design spectrum. Monitoring of the life consumption is therefore essential. Methods and concepts to establish the "used life" are described for two different aircrafts and the influence of A/C-roles and -equipment as well as structural weight increase over time are discussed.
Derived from text
Airframes; Loads (Forces); Structural Failure; Weapon Systems; Static Loads; Corrosion; Degradation; Aircraft Design; Aircraft Structures; Fatigue Life

19970041543 Aeronautical Systems Div., Wright-Patterson AFB, OH United States
CORROSION PREVENTION SYSTEM FOR THE F-16 FIGHTER AIRCRAFT
LaCivita, Kenneth J., Aeronautical Systems Div., USA; Oct. 1996; 28p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Corrosion Prevention System for the F-16 Fighter Aircraft is an excellent example of defining the design, materials, and process selection requirements early in the acquisition program. This process necessitates working closely with the contractors and customers throughout the life of this program and establishing and maintaining a Corrosion Prevention Advisory Board (CPAB). The corrosion prevention system used on the F-16 implements materials, surface treatments, finishes, and coating systems, that provide superior corrosion protection when manufactured and maintained properly. The F-16 has nevertheless suffered from some corrosion related problems. Although many of these problems have been corrected, field corrosion surveys are useful in identifying new issues as well as past problems that have not been adequately addressed. Results of recent field study conducted by the F-16 System Program Office (SPO), miscellaneous items from the CPAB meetings, and continuing changes brought about by environmental, health, and safety compliance provide the need for a strong, dynamic, on-going corrosion prevention program.
Derived from text
Corrosion Prevention; F-16 Aircraft; Fighter Aircraft; Coating; Finishes; Surface Treatment

19970041545 R-Tec, Rolling Hills Estates, CA United States
PROSPECTS OF STRUCTURAL HEALTH MONITORING SYSTEMS
Ratwani, Mohan M., R-Tec, USA; Oct. 1996; 8p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Recent trends in research activities are primarily geared to design future air vehicles smart so as to perform roles beyond those performed by conventional vehicles including: (1) Improved performance; (2) Reduced structural weight; (3) Reduced pilot load; (4) Increased survivability and reliability; and (5) Reduced maintenance requirements. From the structural engineer's point of view the key areas of interest are: (1) Avionics/structures integration to reduce structural weight; (2) Smart structures to improve performance, reduce maintenance cost and improve safety of flight; (3) Smart skins to reduce structural weight and improve antenna performance; (4) Infra-red (IR) signature reduction to improve survivability; and (5) Thermal management to improve performance. The majority of the research in these areas is applicable to future aircraft, however, smart structures technology has applications to in-service aging aircraft to assure the safety of flight and reduce maintenance cost.
Derived from text
Smart Structures; Structural Engineering; Loads (Forces); Cost Reduction; Safety; Structural Weight; Aircraft Design

19970041546 Wright Lab., Wright-Patterson AFB, OH United States
DURABILITY AND DAMAGE TOLERANCE
Rudd, James L., Wright Lab., USA; Oct. 1996; 24p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Durability and damage tolerance are two of the most critical elements of a structural integrity program for aging aircraft. Durability is primarily concerned with economic issues, dealing with maintenance and repair requirements and their associated costs. Damage tolerance is primarily concerned with structural safety, precluding the occurrence of catastrophic failure. Both durability and damage tolerance can affect the operational readiness of aging aircraft. Significant issues involving durability and damage tolerance are widespread fatigue damage (WFD) and structural repairs. This paper considers three topics of widespread fatigue damage.
Derived from text
Durability; Damage; Tolerances (Mechanics); Fatigue (Materials); Aging (Materials); Aircraft Reliability; Maintainability; Economics; Costs; Structural Failure

19980016574 Science Applications International Corp., McLean, VA United States
UNMANNED TACTICAL AIRCRAFT: A RADICALLY NEW TACTICAL AIR VEHICLE AND MISSION CONCEPT
Gardner, Pat, Science Applications International Corp., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 12p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Unmanned Tactical Aircraft (UTA) is a complete air-power system which enables a general purpose high performance aircraft to perform a full range of lethal missions without the physical presence of a pilot in the aircraft. The system allows the pilot to be virtually present, so that his moral and tactical judgment are retained without exposing him to capture or casualty. Without the pilot, the air vehicle will be optimized for a combination of performance and affordability and can be much less complex and expensive than a comparable manned vehicle. UTAs will be effective in a variety of missions in conflict situations but need not be flown in peacetime beyond minimum maintenance needs; training and mission rehearsal will be done using simulations with the actual virtual pilot interface in the loop. This concept will enable unprecedented affordability in the system. Current estimates are up to 40% reduction in acquisition cost and 50% reduction in operations and support cost. A mix of manned aircraft and UTAS, both exploiting the emerging information architecture for targeting and control provides a distinct new option for national air forces which may be unable to afford a "full" force structure of manned aircraft in the constrained budget environments of the future.
Author
Pilotless Aircraft; Fighter Aircraft; Remotely Piloted Vehicles; Military Operations; Aircraft Design; Human-Computer Interface

19980018674 Dassault Aviation, Saint-Cloud, France
VEHICLE CONFIGURATIONS AND AEROTHERMODYNAMIC CHALLENGES *CONFIGURATIONS DE VEHICULES ET DEFIS DE LA CONCEPTION AEROTHERMODYNAMIQUE*
Perrier, P. C., Dassault Aviation, France; Hirschel, E. H., Daimler-Benz Aerospace A.G., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 16p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Sustained hypersonic flight appears as a challenge for 3 classes of concepts quite different in their use: one is relative to constant cruise, the second to transient (but slowly varying) high altitude flight,

the latter to low altitude penetration. For each of the concepts, a review will be presented of the more promising configurations and the associated aerothermodynamic challenges. In conclusion a proposal for a common technology program is given with demonstration filling the envelope of specifications and dealing with the critical points they generate. Slowly varying high altitude flights may be part of the mission of satellite launchers in the acceleration phase or in reentry cross range cruise with or without rebouncing effects. During these flights, convective ratio to radiative heat transfer is a driving parameter of vehicle configuration, associated with the search for better lift over drag ratio. Low altitude penetrators are specified by the high pressure generated and heavy flutter requirements. On the contrary, the search for configurations with relatively low drag and fuel consumption per mile, for a minimum structural weight, leads to configurations of pure cruisers to be at the pinpoint of aerodynamic efficiency only compromised by carry-and-release constraints.
Derived from text
High Altitude; Aerothermodynamics; Aerodynamic Characteristics; Convective Heat Transfer; Radiative Heat Transfer; Flight Altitude

19980018688 Daimler-Benz Aerospace A.G., Munich, Germany
HEAT LOADS IN HYPERSONIC VEHICLE DESIGN
Hirschel, E. H., Daimler-Benz Aerospace A.G., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 10p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Heat load of hypersonic vehicles flying in the earth atmosphere at speeds below 8 km/s are considered. The general aspects are discussed, definitions are given. Surface-radiation cooling as the basic cooling mode is investigated, related peculiarities are explained. It is shown that heat loads are not only of interest for the materials and structure layout, but that strong couplings in both directions exist with the aerodynamic shape and the aerodynamic performance. The heat-loads oriented design as a perspective is discussed. Finally an overview over the status and the development needs of the prediction and verification capabilities is given.
Derived from text
Heat; Hypersonic Vehicles; Surface Cooling; Loads (Forces); Layouts

19980018689 Calspan-Buffalo Univ. Research Center, NY United States
THERMAL LOADS AND PROTECTION SYSTEMS FOR TRANSITIONAL AND SHOCK INTERACTION REGIONS IN HYPERSONIC VEHICLE DESIGN
Holden, Michael S., Calspan-Buffalo Univ. Research Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 10p; In English; See also 19980018672
Contract(s)/Grant(s): SDIO84-93-C-0001; F49620-95-1-0292; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In this paper, we discuss some of the more difficult to predict phenomena that control the sizing of thermal protection systems for sustained hypersonic flight, and the methods which are available to provide estimates of the requirements for backface, film-cooling and transpiration cooling techniques. The prediction of boundary layer transition on leading edges, in regions of pressure gradient, shock interaction and crossflow induced by vehicle incidence, represents key tasks in vehicle design. We review prediction methods that can be used to estimate the thermal loads when transition occurs. Film and transpiration cooling are two techniques that can be employed to flexibly handle the large and spatially-variable heating loads that can occur in shock interaction regions in and around airbreathing propulsion systems for hypersonic vehicles. Correlation of measurements made to assess the performance of these systems are presented to provide estimates of their effectiveness in constant pressure and shock interaction regions.
Derived from text
Film Cooling; Thermal Protection; Loads (Forces); Shock Wave Interaction; Boundary Layer Transition; Propulsion System Configurations; Prediction Analysis Techniques; Hypersonic Flight

19980018690 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Design Aerodynamics, Brunswick, Germany
DESIGN OF HIGH L/D VEHICLES BASED ON HYPERSONIC WAVERIDERS
Eggers, Th., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Strohmeyer, D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 10p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The aerodynamic behavior of a waverider representing the hypersonic lower stage of a TSTO system is discussed. The investigation covers the complete speed range from subsonic high lift up to hypersonic flight close to the design point of the waverider geometries. Several interesting flow phenomena are described which govern the aerodynamic behavior. It is found that the favourable off-design behavior of hypersonic waveriders allows the practical use of waverider vehicles tar away from their particular design flow conditions. Studies concerning the planform show, that the modification of a gothic planform towards combined forebody - delta wing planforms allows a significant improvement of the aerodynamic efficiency L/D in sub- and transonic flow. In addition the longitudinal stability is increased without compromising the favourable high speed qualities. These benefits are partly compensated by an increasing neutral point shift along the trajectory.
Derived from text
Lift Drag Ratio; Hypersonic Flight; Aerodynamic Configurations; Waveriders; Aerodynamic Characteristics; Transonic Flow

19980018695 Aerospatiale, Espace and Defense Branch, Les Mureaux, France
FLIGHT TESTING FOR HYPERSONIC SPEEDS: AN EUROPEAN VIEW
Laruelle, Gerard, Aerospatiale, France; Bonnefond, Thierry, Aerospatiale, France; Sacher, Peter, Daimler-Benz Aerospace A.G., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 6p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The development of future vehicles with sustained hypersonic flight, using air-breathing and/or rocket propulsion, will require new knowledge and technologies which are not yet available and therefore not validated. One of the mandatory next steps before entering prototype work will be to perform flight tests in order to investigate the topics which can not be studied on ground. The present scenario in US (HyTech, X 33, X 34,...), Japan (Orex, Hyflex, Alflex,...) and Europe including Russia shows worldwide effort in exploring the need for flight testing advanced technologies flying at hypersonic speed. This need will be even more evident for future space launchers if reusability is required. In that case, this will mandatorily lead to a step-by-step approach by flight testing technologies using appropriate flying test beds. Airbreathing propulsion is still, of course, most challenging due to the problems of engine/airframe integration and to the lack of flight data during engine operations at hypersonic speed. Even for fully reusable rocket propulsion, a lot of uncertainties must be still necessarily decreased before starting development of a future advanced transportation system.
Derived from text
Flight Tests; Hypersonic Speed; Air Breathing Engines; Reentry Vehicles; Propulsion; Hypersonic Flight; Launchers

19980018696 NASA Dryden Flight Research Center, Edwards, CA United States
NASA HYPERSONIC X-PLANE FLIGHT DEVELOPMENT OF TECHNOLOGIES AND CAPABILITIES FOR THE 21ST CENTURY ACCESS TO SPACE
Hicks, John W., NASA Dryden Flight Research Center, USA; Trippensee, Gary, NASA Dryden Flight Research Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 10p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A new family of NASA experimental aircraft (X-planes) is being developed to uniquely, yet synergistically tackle a wide class of technologies to advance low-cost, efficient access to space for a range of payload classes. This family includes two non-air-breathing rocket-powered concepts, the X-33 and the X-34 aircraft, and two air-breathing vehicle concepts, the scramjet-powered Hyper-X and the rocket-based combined cycle flight vehicle. This report describes the NASA vision for reliable, reusable, fly-to-orbit spacecraft in relation to the current space shuttle capability. These hypersonic X-plane programs, their objectives, and their status are discussed. The respective technology sets and flight program approaches are compared and contrasted. Additionally, the synergy between these programs to

advance the entire technology front in a uniform way is discussed. NASA's view of the value of in-flight hypersonic experimentation and technology development to act as the ultimate crucible for proving and accelerating technology readiness is provided. Finally, an opinion on end technology products and space access capabilities for the 21st century is offered.
Author
Hypersonic Flight; Research Aircraft; Technology Assessment; Reusable Spacecraft; Hypersonics; NASA Programs

19980018699 NASA Langley Research Center, Hampton, VA United States
SCRAMJET ENGINE/AIRFRAME INTEGRATION METHODOLOGY
Hunt, James L., NASA Langley Research Center, USA; McClinton, Charles R., NASA Langley Research Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 12p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Scramjet engine/airframe integration methodology currently in use at the NASA Langley Research Center for design/analysis of hypersonic airbreathing vehicles is presented with illustrative example applications. The matrix encompasses engineering and higher order numerical methods that cover the major disciplines as well as a multi-discipline design/optimization approach.
Author
Engine Airframe Integration; Hypersonic Vehicles; Air Breathing Engines; Design Analysis

19980018700 Aerospatiale Missiles, Bourges, France
AIR INTAKE AND AIR INTAKE / COMBUSTION INTERACTION *ENTREE D'AIR ET INTEGRATION ENTREE D'AIR / CHAMBRE DE COMBUSTION*
Auneau, Isabelle, Aerospatiale Missiles, France; Duveau, Philippe, Office National d'Etudes et de Recherches Aerospatiales, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 14p; In French; See also 19980018672; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

High speed air-breathing vehicle studies (missiles, combines cycle engines single or two stage-to-orbit launchers) have been undertaken at AEROSPATIALE and ONERA for many years. The design of these vehicles requires the study of air intakes. The choice of the air intakes to be installed on a given vehicle is related to different considerations, among which the type of vehicle, its mission and expected performances, other constraints such as propulsive system integration, stealthiness,... The study of inlets can not be uncoupled from the design of other vehicle elements. Indeed, for hypersonic vehicles, the forebody usually acts as a pre-compression ramp and the scramjet injection struts take part of the internal compression process: both of these elements have to be taken into account at the very beginning of the inlet design, as well as flowfield requirements for combustion. For the supersonic vehicles using ramjets, though the forebody flowfield has less importance on the inlet design than for the hypersonic case, strong interactions exist between the inlet and the combustion chamber; and this, not only in terms of system performances, but also in terms of acceptable flowfield distortions for the combustion.
Author
Air Intakes; Combustion Chambers; Supersonic Combustion Ramjet Engines; Forebodies; Hypersonic Vehicles; Flow Distribution; Systems Integration; Hypersonics

19980018701 NASA Langley Research Center, Hampton, VA United States
SYSTEMS CHALLENGES FOR HYPERSONIC VEHICLES
Hunt, James L., NASA Langley Research Center, USA; Laruelle, Gerard, Societe Nationale Industrielle Aerospatiale, France; Wagner, Alain, Societe Nationale Industrielle Aerospatiale, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 18p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper examines the system challenges posed by fully reusable hypersonic cruise airplanes and access to space vehicles. Hydrocarbon and hydrogen fueled airplanes are considered with cruise speeds of Mach 5 and 10, respectively. The access to space matrix is examined. Airbreathing and rocket powered, single- and two-stage vehicles are considered. Reference vehicle architectures are presented. Major systems/subsystems challenges are described. Advanced, enhancing systems concepts as well as common system technologies are discussed.
Author
Air Breathing Engines; Hypersonic Vehicles; Hydrocarbons; Hypersonics; Systems Analysis

19980018702 Air Force Office of Scientific Research, Bolling AFB, Aerospace and Materials Sciences Directorate, Washington, DC United States
SCIENTIFIC BARRIERS TO HYPERSONIC VEHICLE DESIGN
Sakell, Leonidas, Air Force Office of Scientific Research, Bolling AFB, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 6p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper will discuss some of the scientific barriers to operational hypersonic vehicle design. These barriers arise from three primary sources. The first is a lack of fundamental understanding and knowledge of the aerothermodynamic flows, environments and, flow processes which arise over complex, 3D weapon system flight configurations during flight. The second source is the limitations inherent in the numerical simulations of these flows. The third is the lack of hypersonic test facilities which can operate with test times of at least seconds while also duplicating flight enthalpies and Reynolds numbers. My interest centers about the scientific issues arising with actual hypersonic configurations that are of current, planned or, potential mission relevance to the USA Air Force. I will discuss the major barriers in these categories below from the perspective of their impact on hypersonic flight vehicle design and performance.
Derived from text
Aerodynamic Configurations; Aerothermodynamics; Hypersonic Vehicles; Design Analysis; Systems Engineering; Test Facilities; Complex Systems

19980018704 NASA Langley Research Center, Hampton, VA United States
MULTIDISCIPLINARY OPTIMIZATION METHODS FOR PRELIMINARY DESIGN
Korte, J. J., NASA Langley Research Center, USA; Weston, R. P., NASA Langley Research Center, USA; Zang, T. A., NASA Langley Research Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 10p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

An overview of multidisciplinary optimization (MDO) methodology and two applications of this methodology to the preliminary design phase are presented. These applications are being undertaken to improve, develop, validate and demonstrate MDO methods. Each is presented to illustrate different aspects of this methodology. The first application is an MDO preliminary design problem for defining the geometry and structure of an aerospike nozzle of a linear aerospike rocket engine. The second application demonstrates the use of the Framework for Interdisciplinary Design Optimization (FIDO), which is a computational environment system, by solving a preliminary design problem for a High-Speed Civil Transport (HSCT). The two sample problems illustrate the advantages to performing preliminary design with an MDO process.
Derived from text
Design Analysis; Optimization; Statistical Analysis; Aerospike Engines

19980033522 Northrop Grumman Corp., Pico Rivera, CA United States
AFFORDABLE STRUCTURES THROUGH INTEGRATED DESIGN
Wiley, D., Northrop Grumman Corp., USA; Sensburg, O., Daimler-Benz Aerospace A.G., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 10p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Design for Affordability is the new paradigm for the 21st Century. Balancing the conflicting goals of systems superiority and systems affordability is the challenge of the integrated design environment on a larger scale than has ever been done before. This paper discusses the engineering processes and tools of Integrated Design which contribute to affordability of combat aircraft structures. The objectives

of integrated design are to ensure a balanced design so that no single performance parameter dominates the system and to manage the design achieves the optimum in system level performance and affordability. Analyses and simulations reduce the risk in the preliminary design phase, minimizing the amount of testing required for validation prior to production.
Derived from text
Aircraft Structures; Fighter Aircraft; Aircraft Design; Optimization; Balancing

19980033525 Defence Evaluation Research Agency, Systems Integration Dept., Farnborough, United Kingdom
SYNTHETIC ENVIRONMENTS - A TOOL IN COMBAT AIRCRAFT DESIGN
Weeks, R., Defence Evaluation Research Agency, UK; Tomlinson, B., Defence Evaluation Research Agency, UK; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 5p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Combat aircraft design is a complex task requiring a balance to be struck between potentially conflicting requirements. Most recently the very practical consideration of affordability has come to dominate almost every phase of the process. However, the requirement for effectiveness remains. This paper considers how the application of large scale simulation and modelling - dubbed 'Synthetic Environments' can already assist in understanding the issues and trade-offs and goes on to suggest how the potential of the approach may in due course extend to a far wider range of applications. The paper draws on examples of research into Synthetic Environments as an approach and will address some of the work on SEs and their applications in which the UK Defence Evaluation and Research Agency is involved.
Derived from text
Aircraft Design; Fighter Aircraft; Simulation; Costs; Tradeoffs

19980033526 British Aerospace Defence Ltd., Aerodynamics Dept., Preston, United Kingdom
AGILITY IN THE CONTEXT OF IMPROVED OPERATIONAL EFFECTIVENESS
McKay, K., British Aerospace Defence Ltd., UK; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 10p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The environment in which a fighter pilot operates is subject to continual change due to technology advances and the altering world situation. The only prediction which can be made with confidence is that profound change should continue to be expected. The first air to air conflicts occurred in the Great War. Here, aircraft were, for the most part marginal with regard to performance, stability and controllability. Indeed. many combat losses could be attributed to these shortcomings rather than the action of the enemy. However, some of the aircraft were regarded. and still are, as models of the agile fighter, particularly in the hands of an expert pilot, or "ace". The basic skills required were the ability to remain in control and shoot accurately. For subsequent conflicts, the same basic skills were required, although airframes were better stabilised and controlled and had increased power available, resulting in higher speeds. With radar and radio, it became possible to receive guidance towards the targets that the ground control perceived as the prime threat. Weapons remained visual range, however, but regardless of this, the increased speeds and the added information changed the difficulty of the pilot's task due to the implications on his situational awareness and choice of tactics. Increasingly, the combat results became more clouded by the interaction of the systems available to the pilot and his ability to assimilate the information provided.
Author
Combat; System Effectiveness; Ground Based Control; Controllability; Warfare

19980033527 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Aeroelasticity, Goettingen, Germany
THE BENEFITS OF THE PASSIVE AND ACTIVE AEROELASTIC DESIGN OF AIRCRAFT STRUCTURES
Hoenlinger, H. G., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Hutin, P. M., Office National d'Etudes et de Recherches Aerospatiales, France; Pendleton, E. W., Wright Lab., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 24p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The increasing performance requirements and the economical pressure to reduce Direct Operational Costs (DOC's) of new aircraft design can no longer be met by traditional and sequential design processes. This is especially true when considering aeroelasticity. The impact of aeroelastic effects on the design of new high performance transport or fighter aircraft demands the use of multidisciplinary design concepts and optimization strategies in the preliminary design phase or earlier to develop flutter-free structures and to ensure excellent multipoint design characteristics. This paper presents selected examples of a variety of aeroelastic design principles for passive primary aircraft structures and for active structures of advanced aircraft with highly sophisticated fly-by-wire flight control systems.
Derived from text
Aeroelasticity; Aircraft Design; Cost Reduction; Aircraft Structures; Fighter Aircraft; Multidisciplinary Design Optimization; Operating Costs; Design Analysis

19980033530 Naval Air Systems Command, Arlington, VA United States
V/STOL AND STOVL DESIGN CONSIDERATIONS
McErlean, Donald P., Naval Air Systems Command, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 4p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

As has been noted in many studies of this class of aircraft (cf "Aircraft Design Integration" L.M.D.C. Campos, Aerospace 2020) full vertical take off and landing of attack type aircraft (non-rotor powered) has been shown to be an unwise design option. This is due primarily to the substantial amount of thrust which must be provided for vertical lift severely limiting gross weight and therefore either payload or range. However, if even a limited amount of forward motion is provided, so that a conventional lifting wing augments the vertical thrust of the propulsion system the situation changes considerably. This combination of wing and propulsion produced lift has been shown to provide both useful payload/range combinations and significantly shortened take-off roll. Upon completion of the mission, with either payload expended or fuel load consumed, the system is now sufficiently lighter so that vertical landing does become possible. This gives rise to a class of aircraft known as "STOVL" or Short Take Off/Vertical Landing. Obviously one could also design the aircraft with shortened landing distances but not truly vertical. However, an interesting systems trade comes to bear on the problem.
Derived from text
V/STOL Aircraft; Aircraft Design; Takeoff; Vertical Landing; Attack Aircraft

19980033533 Wright Lab., FIIA, Wright-Patterson AFB, OH United States
A DISCUSSION OF A MODULAR UNMANNED DEMONSTRATION AIR VEHICLE
Cherry, Mark C., Wright Lab., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 9p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The idea of an unmanned combat vehicle has existed for many years. We now have the opportunity to capitalize on numerous technologies under development to make an unmanned combat vehicle a viable option for military commanders. The key problems are the issues dealing with the integration of these technologies into a synergistic aeroform, and the human control problems that arise due to these technologies. A modular demonstration platform that can capitalize on new technologies as they mature is a key way to demonstrate the viability of an unmanned combat vehicle, as well as answer some of the questions, and technology challenges, that may arise due to off-board control of a lethal air vehicle. A modular airframe is required in a demonstration platform to flight test and demonstrate various technology sets as they mature. Modularity is important because it provides greater system flexibility and should reduce the life cycle costs of the air vehicles. The demonstration platform must be capable of performing a notional mission similar to what may be envi-

sioned for a combat UAV, in order to show that demonstrated technologies are applicable to production vehicles. The challenges and payoffs of this aggressive vision will be discussed.
Derived from text
Airframes; Cost Reduction; Modularity; Flight Tests; Life Cycle Costs; Combat

19980033534 R-Tec, Rolling Hills Estates, CA United States
AGING AIRFRAMES AND ENGINES
Ratwani, Mohan M., R-Tec, USA; Koul, A. K., Institute for Aerospace Research, Canada; Immarigeon, J-P., Institute for Aerospace Research, Canada; Wallace, W., Institute for Aerospace Research, Canada; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 16p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The presence of aging aircraft fleets has been increasing throughout the world due to the global, financial, and political environment. The reduction in the defense budget of many countries has forced them to use their military aircraft well beyond their original design lives. Also, the demand on the performance of these aircraft has been increasing due to increased payload and severe usage. Maintaining the airworthiness of these aircraft and their propulsion systems while at the same time keeping the maintenance costs low is of prime concern to the operators and regulatory authorities. The flight safety requirements and the performance demands are likely to result in higher maintenance costs. However, the unique opportunities provided by the research and development in the areas of new and improved materials, structures, manufacturing, repairs, and Non-Destructive Inspection (NDI) technologies have made it possible to keep the increase in costs to a minimum and in many cases reduced the overall maintenance costs. This paper discusses the contributions made by research and technology towards lowering the maintenance cost and improving the flight safety of aging airframes and engines.
Derived from text
Airframes; Flight Safety; Aircraft Reliability; Payloads; Inspection; Costs; Propulsion System Performance

19980033536 Defense Advanced Research Projects Agency, Arlington, VA United States
SMART AIRCRAFT STRUCTURES
Crowe, C. Robert, Defense Advanced Research Projects Agency, USA; Sater, Janet M., Institute for Defense Analyses, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 16p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The broad but strongly interdisciplinary field of smart structures and materials seeks to apply multi-functional capabilities to existing and new structures. by definition, smart structures and materials are those which can sense external stimuli and respond with active control to that stimuli in real or near-real time. The most common analogy is to a human (Figure 1): the nervous system senses the stimuli; then the brain processes the information causing a muscle (actuator) to respond. For purposes of this paper, smart structures and materials consist of active devices-primarily sensors and actuators either embedded in or attached to a structure. Smart structures analogy to a human. These smart structures technologies are expected to provide new and innovative capabilities in future military aircraft including fighter and transport aircraft, unmanned aerial vehicles (UAVs), and helicopters and tilt rotorcraft. Specific applications are described in terms of system functional capability enhancements (e.g., vibration damping and suppression) and overall system performance benefits (e.g., reduced life cycle costs).
Derived from text
Smart Structures; Aircraft Structures; Cost Reduction; Fighter Aircraft; Real Time Operation; Sensory Perception; Actuators; Embedding

19980035012 Defence Test and Evaluation Organisation, Rotary Wing Aircraft Dept., Boscombe Down, United Kingdom
SERVICE RELEASE AND 'SAFETY CRITICAL' SOFTWARE
Rodger, K. S., Defence Test and Evaluation Organisation, UK; Advances in Flight Testing; Dec. 1997; 10p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

As is well known, software is increasingly used to improve operational effectiveness. It is also well known that every innovative use of technology results in a change to the types of hazard and therefore introduces the potential for reduced safety. This paper considers what is required to recommend release of aircraft into service when safety is dependent on the "correct" operation of software. The paper starts with a general description of a release to service and of how it should be derived and continues with a discussion of testing its and roles, contributions and its limitations. Since software is inevitably associated with electronics the paper next considers how the safety implications of using electronics should be assessed before consideration of how safety critical software should be treated by certifying authorities. The views expressed in this paper are those of the author and are not necessarily DTEO policy.
Author
Computer Programs; System Effectiveness; Flight Safety

19980035013 Tybrin Corp., Edwards AFB, CA United States
C-17 ENHANCEMENTS TO A FLIGHT TEST PLANNING PROGRAM
Canody, Cheryl, Tybrin Corp., USA; Hewett, Marle D., G and C Systems, Inc., USA; Advances in Flight Testing; Dec. 1997; 10p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper presents the enhancements incorporated into TEST_PLAN, a commercially available flight test planning program, for the C-17 follow-on test program. TEST_PLAN is a software package for UNIX and VMS based workstation computers that allows Flight Test Engineers (FTE's) to plan and track flight test programs by mapping requirements to test points, flights, and flight test maneuvers. TEST_PLAN is integrated with the Oracle Relational DataBase Management System (RDBMS). Test points and requirements are stored in Oracle tables. The software provides automated tools that allows FTE's to query these tables to obtain lists of test points that can be assigned to maneuvers and flights to construct a flight test plan. The 417th Flight Test Squadron (FLTS) at the Air Force Flight Test Center (AFFTC), Edwards Air Force Base (AFB), funded four major enhancements to TEST_PLAN to support the C-17 follow-on flight test program. These enhancements are: (1) incorporation of the C-17 Test Parameter Requirements (TPR) database into TEST_PLAN; (2) implementation of an Instrumentation Discrepancy Report in TEST_PLAN; (3) integration of FrameMaker with TEST_PLAN to implement an automated flight test card generation facility; and (4) instituting a requirements compatibility matrix using Oracle tables and compatibility definitions provided by the administrator. The details of these enhancements are presented in this paper.
Author
C-17 Aircraft; Flight Tests; Data Base Management Systems; Applications Programs (Computers); Planing

19980035015 Defence Test and Evaluation Organisation, Rotary Wing Aircraft Dept., Boscombe Down, United Kingdom
HELICOPTER CERTIFICATION-THE CHALLENGE OF TESTING UK APACHE
Finch, Roger S., Defence Test and Evaluation Organisation, UK; Advances in Flight Testing; Dec. 1997; 14p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In July last year the UK Government announced the eagerly awaited decision on the UK Army's future Attack Helicopter (AH). The UK would purchase 67 WAH-64 APACHE helicopters, a derivative of the McDonnell Douglas Helicopters AH-64D Apache. The aircraft would be produced by GKN Westland Helicopters Ltd, as the Prime Contractor, with McDonnell Douglas Helicopter Systems as the Integrating Sub-Contractor. The WAH-64 would be fitted with a version of the Rolls Royce-Turbomeca RTM 322 engine, currently fitted to the UK's Merlin helicopter. The paper presents an overview of the emergent technologies being considered for the UK Apache, in particular a Defensive Aids Suite (DAS) and Helmet Mounted Displays (HMD). Ideas on a future handling qualities assessment are also presented. Before the first UK Apache arrives at Boscombe Down for clearance testing, the UK Test & Evaluation (T&E) community must develop the required clearance methodologies to evaluate the aircraft as a complete weapons system: preliminary work addressing this issue has already started. Clearance testing will, undoubtably, make greater use of simulation, as well as placing more emphasis on joint testing

with Industry. The challenge facing UK T&E is how to acquire the required test data with the minimum amount of testing to generate the evidence necessary for the aircraft's Military Aircraft Release (MAR).
Author
Helicopter Control; Certification; Helmet Mounted Displays; Military Helicopters

19980035017 Arnold Engineering Development Center, DOM, Arnold AFS, TN United States
BALANCING MODELING AND SIMULATION WITH FLIGHT TEST IN MILITARY AIRCRAFT DEVELOPMENT
Norton, William J., Arnold Engineering Development Center, USA; Dec. 1997; 26p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The use of Modeling and Simulation (M&S) in the development of aerospace vehicles has evolved in step with the associated analytical and computational tools. During this evolution M&S has been balanced with necessary levels of flight testing as an integral part of the development process. Now, program managers are being urged to seek dramatic reductions in flight testing and to compensate with much greater reliance on M&S. A strong emphasis on fostering M&S development is essential to extend the aerospace state-of-the-art, and does hold promise for reducing development cost and cycle time. However, recent test programs do not provide confidence that M&S tools are presently of sufficient accuracy to permit a preponderant reliance on them at the expense of flight test. Premature dependency will introduce the risk that the system deficiencies usually found in flight testing will go undiscovered until after the vehicle is in production and operation. However, a concerted effort to research and correct demonstrated M&S failures to predict certain system characteristics will, given time, allow a complementary reduction in flight testing. This would allow the shifting balance of M&S with flight testing to be managed so as to keep program risks acceptable and ensure the high quality of resulting weapons systems.
Author
Balancing; Models; Simulation; Flight Tests; Software Development Tools; Attack Aircraft

19980035022 British Aerospace Defence Ltd., Military Aircraft Div., Preston, United Kingdom
THE DEVELOPMENT AND USE OF IN-FLIGHT ANALYSIS AT BAE WARTON
Nanson, K. M., British Aerospace Defence Ltd., UK; Ramsay, R. B., British Aerospace Defence Ltd., UK; Dec. 1997; 16p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes the development and use of telemetry and in-flight analysis for flight trials at BAe Flight Test Warton. The current status of in-flight aerodynamic analysis techniques for Eurofighter is described, including those used for envelope expansion flutter testing. The cost benefits of monitoring and analysis, and the improvement in timescale of data availability, have been demonstrated to support the extension of the in-flight analysis concept to the complete weapon system flight trails.
Author
Telemetry; Flight Tests; Aerodynamic Characteristics; Technologies

19980035023 Computer Sciences Corp., El Segundo, CA United States
REDEFINING FLIGHT TESTING: INNOVATIVE APPLICATION OF THE WORLD WIDE WEB
Hughes, Michael C., Computer Sciences Corp., USA; Gardner, Lee S., Air Force Flight Test Center, USA; Painter, Darcy S., Air Force Flight Test Center, USA; Dec. 1997; 8p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Application of World Wide Web technology to Flight Test is discussed. Examples of how efficiencies in processing flight test data have been gained using an "Intranet" are presented. The Air Force Flight Test Center has successfully used an Intranet to reduce the support staff for post-flight data processing by 90% over the past four years. Techniques are discussed, illustrated by examples, to demonstrate that Intranets have broad application to the Flight Test business. The application of Web technology to manage financial data in the EDGE project is discussed.
Author
Flight Tests; Technology Utilization; Data Processing

19980035024 Aerospatiale, Direction des Essais en Vol, Toulouse, France
IN-FLIGHT TESTS OF THE A300-600-ST 'BELUGA' *ESSAIS EN VOL DE L'A300-600-ST 'BELUGA'*
Destarac, Guy, Aerospatiale, France; Dec. 1997; 8p; In French; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In-flight tests of the A 300-600 ST 'Beluga', built by Aerospatiale and Daimler Benz Aerospatiale Airbus, were given to the Direction des Essais en Vol of the Branche Anions de l'Aerospatiale. This paper describes the installation of measures and the tools mounted on the first airplane for development and certification in-flight tests. It shows the means utilized for data processing and acquisition. The evaluation at the end of the test campaign shows that: the unexpectedly good behavior of the airplane in flight has compensated for the time required to resolve structural problems, the development of the charging system took longer than expected but did not delay the certification flights which were completed by the end of July 1995.
Author
In-Flight Monitoring; Data Processing; Data Acquisition

19980035025 Divisione Aerea Studi Ricerche e Sperimentazioni, Reparto Sperimentale Volo, Pratica di Mare, Italy
THE CERTIFICATION PROCESS OF THE OPHER SMART MUNITION ON THE AMX AIRCRAFT
Petraroli, E., Divisione Aerea Studi Ricerche e Sperimentazioni, Italy; Israeli, D., Elbit Systems Ltd., Israel; Advances in Flight Testing; Dec. 1997; 12p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Italian Air Force (ITAF) has been seeking a low cost smart munition capable to attack vehicular targets with particular reference to armored vehicles and tanks. Low cost implies a guided weapon such as a laser bomb. The main objections to a laser guided weapon, such as those ones belonging to the Paveway family, derived from two intrinsic limitations: laser bombs require an illuminator (not a fire-and-forget weapon); and overall accuracy decreases dramatically with delivering energy. On the other hand, adoption of a missile would have increased both integration and procurement costs. So, it was decided to test the OPHER system in a different scenario with respect to that one which the system was originally designed for: (1) the Italian scenario, characterized by Mediterranean scrub, could have affected system performance in a different way with respect to Israeli desert; (2) the AMX can deliver weapons with an energy much lower than the F-4, on which this weapon has been employed in the Israeli Air Force; and (3) the AMX is equipped with a twin store carrier and the F-4 version of the OPHER system could not fit on it. The result of the successful testing and analytical work described in this paper led to the certification of the OPHER smart munition on the AMX for the Italian Air Force.
Author
Armed Forces (Foreign); Certification; Laser Weapons; Targets

19980035026 Dassault Aviation, Istres, France
IN-FLIGHT TESTS OF THE RAFALE *LES ESSAIS EN VOL DU RAFALE*
Castagnos, Patrick, Dassault Aviation, France; Tourtoulon, Marc, Centre d'Essais en Vol, France; Dec. 1997; 22p; In French; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The in-flight tests of the RAFALE presented the opportunity to face difficult challenges, to initiate new testing techniques, and to adopt new organizational approaches. Since 5 years have elapsed since the 1st flight of the RAFALE C01 and the 4 prototypes have logged over 2300 flights, it seemed appropriate to conduct a comparison between inflight tests as planned in 1990, and as they have in fact taken place up to the present. The two articles that follow undertake this analysis. The first is dedicated more specifically to the aspects of

costs, general objectives of the program and the status of technical refinements. The second is more centered on state-industry relations and optimizing skills and resources.
Author
In-Flight Monitoring; Costs; Industries

19980035027 Westland Helicopters Ltd., Flight Test Dept., Yeovil, United Kingdom
THE EH101 DEVELOPMENT PROGRAMME
Hazzard, Mark, Westland Helicopters Ltd., UK; Dec. 1997; 8p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes the EH101 helicopter flight development programme from initial conception to the present day. Lessons learned during the testing phase are highlighted and significant milestones achieved are detailed. In particular the early development testing is described in some detail.
Author
Helicopters; In-Flight Monitoring; Flight Tests

19980035032 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Flight Mechanics, Brunswick, Germany
X-31A TACTICAL UTILITY FLIGHT TESTING
Friehmelt, Holger, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Guetter, Richard, Daimler-Benz Aerospace A.G., Germany; Kim, Quirin, Bundesluftwaffe, Germany; Advances in Flight Testing; Dec. 1997; 10p; In English; See also 19980035004; Sponsored in part by FMOD.; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The two X-31A were jointly built by Daimler-Benz Aerospace AG and Rockwell International. These German-American experimental aircraft were designed to explore the new realm of flight far beyond stall by employing advanced technologies like thrust vectoring and sophisticated flight control systems. The X-31A aircraft is equipped with a thrust vectoring system consisting of three aft mounted paddles to deflect the thrust vector in both pitch and yaw axes, thus providing the X-31A in this 'Enhanced Fighter Maneuverability program with an agility and maneuverability never seen before. The tactical utility of the X-31A using post stall technologies has been revealed in an extensive flight test campaign against various current state-of-the-art fighter aircraft in a close-in combat arena. The test philosophy included both simulation and flight test. The tremendous tactical advantage of the X-31A during the tactical utility evaluation flight test phase was accompanied by a deepened insight into post stall tactics its typical maneuvers, impacts on pilot-aircraft interfaces and requirements for future weapons to both engineers and the military community. Some selected aspects of the tactical utility of the X-31A using post stall technologies unveiled by the International Test Organization are presented here.
Author
Flight Tests; X-31 Aircraft; Thrust Vector Control; Design to Cost

19980035033 Eurofighter Jagdflugzeug G.m.b.H., Hallbergmoos, Germany
THE EUROPEAN FIGHTER AIRCRAFT EF2000 FLIGHT TEST PROGRAMME OVERVIEW AND MANAGEMENT CONCEPT
Herr, Michael, Eurofighter Jagdflugzeug G.m.b.H., Germany; Butcher, Paul, Eurofighter Jagdflugzeug G.m.b.H., Germany; Dec. 1997; 12p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Eurofighter 2000 (EF2000) Flight Test programme began with first flight in 1994. The aircraft will enter service at the beginning of the next century. In addition to the challenge of basic certification of the airframe with many different Air-to-Air and Air-to-Ground stores configurations, Eurofighter Partner Companies are also conducting testing to fully integrate the new developed Radar (ECR90) and Engine (EJ200). This paper constitutes a description of the EUROFIGHTER Weapon System, the flight test programme management, an overview of the test programme plan and progress to date and discussion of unique challenges during testing. Up to now the EF2000 flight test programme has proceeded as planned and in-service certification should occur on schedule. The achievements reached so far can be attributed to a well designed and built aircraft, a comprehensive test plan, a very reliable data system, and the personal efforts of thousands of people in four different countries.
Author
Fighter Aircraft; Flight Tests; Project Management

19980035034 Information Spectrum, Inc., Falls Church, VA United States
THE V-22 OSPREY INTEGRATED TEST TEAM: A PERSPECTIVE ON ORGANIZATIONAL DEVELOPMENT AND TEAMING
VanderVliet, Gery M., Information Spectrum, Inc., USA; Price, Robert C., Price (Robert C.), USA; Advances in Flight Testing; Dec. 1997; 8p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In February of 1993 the US Navy's V-22 Osprey Program Management Team established a new way of managing its flight test program. This newly established flight test organization would be a departure from what the Navy Test and Evaluation (T&E) community had been used to, especially for an Acquisition CATegory One (ACAT I) program. It was that February that the V-22 Osprey Program Manager (PMA) would sign into contract the establishment of the Navy's first Integrated Test Team (ITT). The V-22 ITT, following in the path of the Air Force Combined Test Force (CTF) concept, would encounter and overcome many challenges. Soon after the V-22 ITT would be established, the Navy's F-18E/F program would follow suit with its own ITT, validating the worthiness of such an organizational concept. This paper discusses the conception, development, benefits, challenges, and lessons learned associated with the setup and operation of the V-22 Osprey ITT. This paper is written as a perspective from government ITT management only.
Author
V-22 Aircraft; Flight Tests; Management Methods; Management Planning

19980201664 Wright Lab., Control Systems Development Branch, Wright-Patterson AFB, OH United States
EMERGING MILITARY UNMANNED AIR VEHICLE SYSTEM CONCEPTS
Ramage, James K., Wright Lab., USA; Dec. 1997; 10p; In English; See also 19980201657; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Unmanned Air Vehicle (UAV) systems are evolving with unprecedented mission area capabilities. Next generation military UAV's offer the potential for achieving a revolutionary reduction in the total cost of conducting tactical air warfare. Exploiting the full potential of UAV's in terms of overall cost and mission capability is highly dependent on the ability to safely operate quasi-autonomously in a dynamic multi-vehicle combat environment. Continuous remotely piloted techniques and fixed pre-determined way point flight trajectory systems of the past, are giving way to more highly automated vehicle management systems to provide variable system integrity and user confidence. Development of multi-dimensional guidance and control, adaptive agent based flight management and information fusion technologies represent the essential enabling elements to permit safe and effective operational employment of unmanned strike aircraft. As the military community develops and matures the UAV technology base, commercial spin-off applications are also beginning to emerge, e.g. law enforcement, ground traffic surveillance, maritime patrols, and wide area telecommunication. The combined commercial and military UAV application trend will have serious implications with respect to civil airspace usage and associated vehicle certification requirements and standards.
Author
Military Technology; Pilotless Aircraft; Remotely Piloted Vehicles; Flight Management Systems; Automatic Flight Control; Systems Integration

19980237546 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
AIRCRAFT DESIGN INTEGRATION AND AFFORDABILITY *L'INTEGRATION DE LA CONCEPTION AERONAUTIQUE ET LE COUT DE POSSESSION ACCEPTABLE*
Campos, Luis Manuel Braga da Costa, Instituto Superior Tecnico, Portugal; Nov. 1998; 120p; In English
Report No.(s): AGARD-R-826; ISBN 92-836-1065-2; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

This AGARD Advisory Report, was from the Flight Vehicle Integration Panel input to the AGARD study Aerospace "2020". This report examines the difficult questions of capability and affordability. The report focuses on the relevant trends in operational requirements and the technologies available to achieve these requirements. The report considers the affordability of forces as a main issue for the future. Topics include: a discussion in operational requirements, the technology available, advanced structures and materials, systems integration, types of air vehicles, and the affordability of forces. Technologies are assessed from the viewpoints of both potential capabilities and threats. Recommendations and conclusions are presented.
Author
Technology Assessment; Military Aircraft; Air Defense; Aircraft Design; Aircraft Production Costs; Product Development; Research and Development; Systems Integration

19990007837 Lockheed Martin Corp., Palmdale, CA United States
DESIGN GUIDELINES AND CONSIDERATIONS FOR THE UTA
Nicolai, Leland M., Lockheed Martin Corp., USA; Jul. 1998; 10p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Unmanned Tactical Aircraft is viewed by many as the centerpiece for affordable tactical air warfare in the year 2020 due to its potential for a revolutionary reduction in LCC and the fact that it embodies most of the Aerospace 2020 technology initiatives. Most of the technology for making the UTA effective as a weapon system is here today, but the technology for realizing its potential cost reduction remains to be developed.
Author
Pilotless Aircraft; Design Analysis; Cost Reduction

19990007840 Naval Air Warfare Center, Weapons Div., China Lake, CA United States
HIGHLY MANEUVERABLE LETHAL VEHICLE (HMLV) CONCEPT
Palfalvy, George M., Naval Air Warfare Center, USA; Andes, David K., Naval Air Warfare Center, USA; Siegel, David, Office of Naval Research, USA; Jul. 1998; 6p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The paper presents interim results of a technology feasibility study of an unoccupied, armed, reusable, semi-autonomous air weapon system- the Highly Maneuverable Lethal Vehicle (HMLV). The HMLV concept that is currently being studied nominally has the following characteristics: (1) Acceleration capability greater than that of any manned aircraft; (2) Sensors, sensor processing, automatic target recognition algorithms and reasoning/decision-making algorithms to allow it to operate almost completely autonomously; (3) A variable-bandwidth, jam-resistant data-link to communicate images to an offboard controller; (4) Lightweight, inexpensive, but precision guided and highly lethal, weaponry to prosecute air and surface targets; and (5) Airborne refueling capability. The study's goal is to examine applicable technologies and determine where they are lacking so that research funding can be properly focused. Interim results indicate that: (1) High-g airframes can he built (range and loiter capability for these airframes may be an issue); (2) Turbojet engines that can withstand the high-g environment can be built; (3) Sensor and signal-processing research is progressing at a rate that will produce sufficient capability in the near future; (4) The high-g capability of the HMLV, combined with a simple infrared countermeasure, will allow it to evade most threat missiles; and (5) Advances in computational algorithms, including ATR, will be required.
Author
Highly Maneuverable Aircraft; Pilotless Aircraft; Feasibility Analysis

19990007844 Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn, Germany
SYSTEM INTEGRITY CONSIDERATIONS FOR UNMANNED TACTICAL AIRCRAFT
Scheithauer, D., Industrieanlagen-Betriebsgesellschaft m.b.H., Germany; Wunderlich, G., Industrieanlagen-Betriebsgesellschaft m.b.H., Germany; Jul. 1998; 12p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In general, unmanned aerial vehicles (UAVS) and Cruise Missiles (CM) have demonstrated their operational value in the limited conflicts of the last years. This experience and technological advances promise similar successful results for more sophisticated Unmanned Tactical Aircraft (UTA) covering a wider range of airborne mission roles. Throughout this publication the term UTA will be used in favor of the term uninhabited combat aerial vehicle (UCAV). In this paper UTA concepts are evaluated with respect to system integrity. In a first step mission scenarios are analyzed with respect to the hostile threats an UTA will encounter. These external threats together with internal threats affecting reliability and system safety are the reference for the evaluation of the required integrity levels. On the basis of a generic system architecture essential and non-essential functions are considered. The assessment led to the result that UTA will be quite complex. This will have a major impact on the life cycle costs according to the experience with manned aircraft programs. However, compared with manned aircraft weapon systems UTA life cycle costs will be lower due to fewer operating costs.
Author
Cruise Missiles; Pilotless Aircraft; Systems Engineering; Weapon Systems; Design Analysis; Threat Evaluation

19990007846 Wright Lab., Aeromechanics Integration Branch, Wright-Patterson AFB, OH United States
UNCONSTRAINED MANEUVER AIR VEHICLE: A CONFIGURATION DEVELOPMENT
Shenk, Barth W., Wright Lab., USA; Jul. 1998; 10p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Maneuverability-based sizing of a notional, unmanned air vehicle is presented with spin tunnel test results of a resultant configuration. Sustained load factor and roll acceleration were traded against wing loading, thrust-to-weight ratio and aspect ratio for a notional air-to-air combat mission. Prospective turn and roll performance goals were developed for an unmanned fighter, and physical limitations of thrust matching between cruise and maneuver power requirements was studied. The resulting configuration characteristics indicate that optimization of this class of vehicle requires development of inertial optimization methods and structural design methodologies for instantaneous, dynamic loads.
Author
Highly Maneuverable Aircraft; Structural Design; Pilotless Aircraft; Optimization; Aircraft Configurations; Spin Tests; Aircraft Design

19990007848 Papachristofilou (I.), Thessaloniki, Greece
SYSTEM LAYOUT OF AN UNMANNED HIGH ALTITUDE AIRCRAFT FOR CERTIFICATION AND FLIGHT IN CIVIL AIRSPACE
Papachristofilou, I., Papachristofilou (I.), Greece; Kaempf, P., Daimler-Benz Aerospace A.G., Germany; Wagner, O., Technische Univ., Germany; Jul. 1998; 8p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Several unmanned air vehicles (UAVs) are currently in operation or under development, and predictions for the future indicate an expansion in the tasks that will be covered by UAVs. With missions conceivable both in the civil as well as military sectors, UAVs are expected to be procured and operated in increasing numbers in the immediate future. However, besides the technical challenges associated with unmanned flight, the issues of certification and rules of operation of unmanned aircraft in non-restricted airspace need to be addressed. Flights of unmanned aircraft are currently taking place within reserved airspace with only few exceptions where UAVs have been allowed to enter open airspace under special precautions. The potential of unmanned aircraft can only be exploited if such restrictions are lifted and they are certified to operate along manned aircraft. to reach such a point, formulation of explicit certification requirements on the system design of the aircraft is required, as well as a series of flight tests to validate the concept of safe use of unmanned aircraft in non-restricted airspace. Although such regulations do not exist at the moment, airworthiness and air traffic control authorities have already started examining the issues involved and are expected to issue guidelines covering unmanned flight in the near future. Based on information available from the above mentioned authorities, the main characteristics of those regulations can be described at the present time. Moreover, the implications on the system design of unmanned aircraft can be highlighted, showing the parameters that are to influence future designs. In our view the least complicated route to the operation of unmanned aircraft in civil airspace can be explored with a subsonic high altitude reconnaissance platform. Here the relocation of the pilot to a ground station offers the highest benefits, creating a strong ratio-

nale for the development of such a craft. At the same time, only a limited number of additional subsystems are necessary to facilitate flight in open airspace, which will be demonstrated by means of a recently concluded conceptual design of an unmanned high altitude aircraft.
Author
Pilotless Aircraft; Aircraft Design; Systems Engineering; Airspace; Control Systems Design

19990007849 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
HYPERSONIC DRONE FOR RECONNAISSANCE MISSIONS IN DEPTH *DRONE HYPERSONIQUE POUR DES MISSIONS DE RECONNAISSANCE EN PROFONDEUR*
Serre, L., Office National d'Etudes et de Recherches Aerospatiales, France; Jul. 1998; 10p; In French; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The concept of using a hypersonic drone aircraft operating at very high altitude is analyzed. One example of an operational flight is obtaining an important class of information which is difficult to obtain by other means. Of equal importance, the mounting of sensors is strongly connected with the size of the vehicle, and must, by this standard, be considered in the preliminary project for finalizing the main options.
Transl. by CASI
Drone Aircraft; Hypersonic Aircraft; Reconnaissance

19990008563 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
ENHANCEMENT OF AIRCRAFT GROUND HANDLING SIMULATION CAPABILITY *L'AMELIORATION DES MOYENS DE SIMULATION DES MANOEUVRES AU SOL DES AERONEFS*
Barnes, A. G., Advisory Group for Aerospace Research and Development, France; Yager, T. J., NASA Langley Research Center, USA; Aug. 1998; 88p; In English
Report No.(s): AGARD-AG-333; . AGARDograph-333; ISBN 92-836-1066-0; Copyright Waived; Avail: CASI; A05, Hardcopy; A01, Microfiche

This report is a guide to methods of representing in a flight simulator, the stability and control of an aircraft on the ground. It updates an earlier publication, AGARDograph 285, in the light of simulation technology improvements over a ten year period. Emphasis is placed on the modeling of the vehicle dynamics, and on the modeling of the tire forces generated by the runway surface. Areas are identified where some current simulators are deficient. The different needs of pilot-in-the-loop and non-real-time simulations are discussed, and topics for further research are identified.
Author
Flight Simulators; Ground Handling; Computerized Simulation; Mathematical Models; Pilot Support Systems; Flight Simulation

19990014356 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
PILOT TESTING IN VIRTUAL ENVIRONMENTS
Weeks, Joseph L., Advisory Group for Aerospace Research and Development, France; Siem, Frederick M., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 11-12; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

In the 1980's, applicants to undergraduate pilot training were tested on verbal and quantitative achievement while seated at a desk with pencil and paper. In this decade, applicants are also tested on information processing performance and psychomotor performance while seated at a personal computer with joy sticks and a keypad. by 2020, applicants to undergraduate pilot training, could don goggles and data gloves and enter a virtual environment for the measurement of leadership and team work. Major improvements in pilot testing have been achieved by augmenting the measurement of verbal and quantitative achievement with the measurement of information processing and psychomotor performance. A large evidentiary basis has been established to demonstrate that pencil and paper selection tests measure the abilities important for piloting an aircraft. The addition of measures of information processing and psychomotor performance increment the validity of pencil and paper testing by more than fifty percent. The next major improvement in pilot testing could be accomplished by the measurement of leadership and team work by using virtual reality computer technology.
Author
Pilot Training; Performance Tests; Virtual Reality; Psychomotor Performance; Information Processing (Biology); Leadership

19990014359 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
ROTORCRAFT 2020
Blake, Bruce B., Advisory Group for Aerospace Research and Development, France; Tischler, Mark B., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 40-43; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Rotorcraft have played a key role in all recent conflicts, as witnessed by use of AH-64's in the opening days of the Gulf War to neutralize Iraqi border defense, and the continuing rotorcraft role in regional conflicts including Somalia, Iraq and Bosnia. Emerging rotorcraft systems coming on-line in the NATO countries during the coming decade include the Comanche, Tiger, NH-90, EH101, and V-22. These systems will exhibit improved capabilities in weapons integration, all-weather operations, and will have increased performance and agility. Future systems envisioned for the 2020 timeframe will make full use of active control technology and smart structures to reduce noise and vibration and increase agility in a care-free maneuvering vehicle. Advances in avionics and GPS technology will be integrated in an advanced glass cockpit that allows for increasingly accurate navigation and weapons delivery in all weather conditions with a tolerable pilot workload. Increased use of integrated modular avionics architecture will improve mission reliability, facilitate maintenance and improve supportability. Further, the full use of unmanned air vehicle (UAV) technologies in a combined manned-unmanned force structure will dramatically improve mission effectiveness without exposing the pilots to unnecessary risks in hostile territory. This paper explores the vision for future rotorcraft technologies as an important component of AGARD Aerospace 2020.
Author
Rotary Wing Aircraft; Technology Assessment

19990014376 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
REQUIRED R AND D IN AIRFRAME STRUCTURES AND MATERIALS FOR COMBAT AIRCRAFT
Olsen, James J., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 108-115; In English; See also 19990014353; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper compiles and interprets requirements from several sources in the USA for Required R&D in Airframe Structures and Materials for Combat Aircraft. The paper covers: (1) The processes of developing requirements; (2) Previous studies, sources of the requirements; (3) Required R&D; and (4) Some ideas on collaboration within the laboratories, aerospace industry and possibly NATO.
Author
Aircraft Structures; Fighter Aircraft; Research and Development; Airframe Materials; Structural Design

19990014378 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
INTEGRATED AIRFRAME DESIGN TECHNOLOGY
Sensburg, Otto, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 119-120; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Integrated Airframe Design Technology is an important element of a number of activities required to improve the business performance of Aircraft companies worldwide. The customers require more reliable products at an affordable price that perform to specification and are easy to support in service. The time required to design and build an aircraft needs to be reduced and also an environment created whereby all parties involved can work together to influence the development of the design at an early stage. This approach coupled with enhanced visualization and simulation of both the functional and physical elements of the product design will enable modifications to be implemented as part of the design process before the start of manufacturing/

build. Thus the need for changes to be carried out during and after production build will be significantly reduced and will result in impressive savings in costs. Integrated Airframe Design Technology provides the basis for this new environment to be developed.
Derived from text
Airframes; Systems Integration; Design Analysis; Aircraft Design

19990014380 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
MAINTENANCE-FREE AIRCRAFT
Welburn, Steve, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 126-127; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Although the ultimate aim of a maintenance-free aircraft may never be achieved, the Aerospace 2020 report highlights the huge cost savings that would result from a substantial reduction in aircraft maintenance costs. The route to achieve these savings has to be via the correct specification of reliability targets for the next generation of aircraft procurement. In particular, reliability throughout the complete mission should be specified as a prime operational performance characteristic of new equipment as it is the ultimate verification of the effectiveness of any weapon system. However, as new equipment to meet new missions becomes increasingly complex, the specification of mission reliability, and the subsequent assurance that the required reliability has been delivered, becomes extremely difficult. Life Cycle Costs (LCC) need to be addressed from the earliest days of a project, in feasibility studies, and followed through into the design and acquisition stage since 90% of LCC may be determined by the decisions made before production of a new weapon systems begins. This paper highlights the emphasis now being placed on maintenance free operating periods for aircraft rather than the traditional approach of assessing mean time between failures for individual equipment.
Derived from text
Aircraft Maintenance; Cost Reduction; Life Cycle Costs; Weapon Systems; Aircraft Design

19990014381 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
AGEING AIRCRAFT
Sampath, Sam G., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 128-130; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Aging Aircraft concerns have dramatically escalated in military and civilian quarters alike during the past few years. The percentage of aircraft that are being operated beyond their design lives is ever increasing. As of 1993, approximately 51% of the aircraft fleet in the US Air Force (USAF) was over 15 years old and 44% was over 20 years old. Yet, some aircraft models that have already served NATO for 30 years or more may need to be retained for another two decades. Due to NATO's changing role which includes peace keeping missions remote from home bases, the requirement of unimpaired high operational capacity, higher utilization of its air fleets, and budgetary stringency's, prospects are for aging aircraft problems to continue to become more acute. Aging Aircraft has several connotations. Among them: (a) technological obsolescence, (b) system upgrades, (c) changing mission requirements unanticipated during design specification and development, (d) the spector of runaway maintenance costs, (e) decreased safety, (f) impairment of fleet readiness, (g) unavailability of home depot facilities. If there is one common denominator among these connotations it is that the cost of operating aging aircraft can be very high. However, technical solutions will be available to fleet managers to deal with the problem of aging aircraft in 2020.
Derived from text
Military Aircraft; Aging (Biology); Service Life; Cost Estimates; Long Term Effects

19990014383 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
SMART STRUCTURES AND MATERIALS IN AEROSPACE APPLICATIONS OF NEXT GENERATION
Boller, Christian, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 133-140; In English; See also 19990014353; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Development in disciplines such as sensing technology, computation, control, micromechanics, materials including processing and many others have made significant progress during the past decades. This progress has been mainly possible through an in-depth analysis of the different aspects in these disciplines. to consequently take more advantage of this progress a synergy between these different disciplines has to be established, resulting in what has been termed to be smart materials and structures. Smart (alternatively; active, adaptive, multifunctional or intelligent) materials and structures is, briefly explained, the integration of sensing and actuation elements into a structure or even more ambitiously into a material, with sensor actuator being linked by a controller. Materials actually favored for integration include optical fibers and piezoelectric materials with respect to sensors, piezoelectric/electrostrictive materials, shape memory alloys and electro-rheological fluids with respect to actuators and microprocessors, neural networks, fuzzy logic and various types of signal processing with respect to control. Since performance of aircraft and spacecraft has progressed in a sequence of steps in the past, smart materials and structures technology can thus be considered to be the next step in enhancement.
Author
Smart Structures; Systems Integration; Smart Materials; Structural Engineering; Aerospace Engineering

06
AIRCRAFT INSTRUMENTATION

19950026076 NASA Langley Research Center, Hampton, VA, United States
A HIGHLY RELIABLE, HIGH PERFORMANCE OPEN AVIONICS ARCHITECTURE FOR REAL TIME NAP-OF-THE-EARTH OPERATIONS
Harper, Richard E., Draper, Charles Stark Lab., Inc., USA; Elks, Carl, NASA Langley Research Center, USA; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 14 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

An Army Fault Tolerant Architecture (AFTA) has been developed to meet real-time fault tolerant processing requirements of future Army applications. AFTA is the enabling technology that will allow the Army to configure existing processors and other hardware to provide high throughput and ultrahigh reliability necessary for TF/TA/NOE flight control and other advanced Army applications. A comprehensive conceptual study of AFTA has been completed that addresses a wide range of issues including requirements, architecture, hardware, software, testability, producibility, analytical models, validation and verification, common mode faults, VHDL, and a fault tolerant data bus. A Brassboard AFTA for demonstration and validation has been fabricated, and two operating systems and a flight-critical Army application have been ported to it. Detailed performance measurements have been made of fault tolerance and operating system overheads while AFTA was executing the flight application in the presence of faults.
Derived from text
Architecture (Computers); Avionics; Breadboard Models; Computer Systems Design; Fault Tolerance; Flight Control; Mathematical Models; Nap-Of-The-Earth Navigation; Real Time Operation; Terrain Following

19950026082 Sextant Avionique, Saint Medard en Jalles, France
A HELMET MOUNTED DISPLAY FOR NIGHT MISSIONS AT LOW ALTITUDE *UN VISUEL DE CASQUE POUR LA MISSION DE NUIT A BASSE ALTITUDE*
Cursolle, Jean-Pierre, Sextant Avionique, France; Leger, Alain, Sextant Avionique, France; Leppert, Franck, Sextant Avionique, France; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 10 p; In French; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The achievement of air to ground mission in a complex operational context, with bad meteorological conditions and, moreover by night is a very demanding task for the pilot. This mission requests a high situation awareness which can only be reached with specific, accurate and reliable means, such as sensors, displays or controls, perfectly integrated in the aircraft system. The mission can be successfully realized thanks to sensors performances. But, the use of FLIR or I(sup 2)T depends on a lot of conditions such as weather with

bad effects on the efficiency. So images must be enhanced with symbols to be fully exploitable. Furthermore, the sensors have to be fully integrated, the efficiency depending on the interfaces such as displays and controls. The third Generation Helmet Mounted Display is an answer to this requirement but has to be fighter pilot customized. The conference will include a few operational requirements recall, the Sextant Gen 3 HMD description and will highlight the first symbology results issued from a ground simulation assessment.
Author
Display Devices; FLIR Detectors; Helmet Mounted Displays; Human Factors Engineering; Infrared Imagery; Low Altitude; Navigation Aids; Night Vision; Systems Integration

19960003406 Integrity Systems, Inc., Belmont, MA, United States
FEDERATED FILTER FOR FAULT-TOLERANT INTEGRATED NAVIGATION
Carlson, Neal A., Integrity Systems, Inc., USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 265-280; In English; See also 19960003395
Contract(s)/Grant(s): F33615-87-C-1520; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes federated filter applications to integrated, fault-tolerant navigation systems. The federated filter is an optimal or near-optimal estimator for decentralized, multisensor data fusion. Its decentralized estimation architecture is based on theoretically sound information-sharing principles. Federated filters consist of one or more sensor-dedicated local filters, generally operating in parallel, plus a master combining filter. The master filter periodically combines (fuses) the local filter solutions to form the best total solution. Fusion generally occurs at a reduced rate, relative to the local measurement rates. The method is well suited to real-time system implementation, and can provide significant improvements in data throughput, fault tolerance, and system modularity. This paper discusses federated filter applications to integrated navigation system sin terms of operating modes, accuracy, fault tolerance, computational efficiency (throughput), and real-time system features. Numerical simulation results are presented to demonstrate federated filter performance characteristics.
Author
Fault Tolerance; Filters; Multisensor Applications; Multisensor Fusion; Navigation; Performance Prediction; Systems Integration; Technology Assessment

19960003410 McDonnell-Douglas Aerospace, Saint Louis, MO, United States
AEROSPACE NAVIGATION SYSTEMS REQUIREMENTS FOR FIXED WING AIRCRAFT
Bedoya, Carlos A., McDonnell-Douglas Aerospace, USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 330-380; In English; See also 19960003395; Copyright; Avail: CASI; A04, Hardcopy; A04, Microfiche

The purpose of this paper is fourfold: (1) to provide the radar with a status report on the state-of-the-art of navigation system technology as applied to fixed wing aircraft; (2) recommend a disciplined systems engineering process to be used in determining navigation system requirements as they relate to navigation, sensor cueing and targeting as well as weapon requirements; (3) examples of how to functionally decompose each aircraft and analyze its mission requirements into the navigation system requirements; and (4) a typical set of requirements for a fixed wing aircraft. The results will allow the navigation systems designer to have a process he can follow in determining or verifying the requirements of a particular application as well as a baseline set of requirements.
Author
Air Navigation; Control Systems Design; Design Analysis; Inertial Navigation; Navigation Instruments; Space Navigation; Systems Engineering; Systems Integration

19960023117 McDonnell-Douglas Aerospace, Advanced Crew Systems., Saint Louis, MO United States
TACTICAL COCKPITS: FLAT PANEL IMPERITIVES
Adam, Eugene C., McDonnell-Douglas Aerospace, USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 9-1 - 9-7; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A cockpit revolution is in the making. Many of the much ballyhooed, much promised, but little delivered technologies of the 70's and 80's will finally come of age in the 90's just in time to complement the data explosion coming from sensor and processing advances. Technologies such as helmet systems, large flat panel displays, speech recognition, color graphics, decision aiding and stereopsis, are simultaneously reaching technology maturities that promise big payoffs for the third generation cockpit and beyond. The first generation cockpit used round dials to help the pilot keep the airplane flying right side up. The second generation cockpits used Multifunction Displays and the HUD to interface the pilot with sensors and weapons. What might the third generation cockpit look like? How might it integrate many of these technologies to simplify the pilots life and most of all: what is the payoff? This paper will examine tactical cockpit problems, the technologies needed to solve them and recommend three generations of solutions.
Author
Display Devices; Cockpits; Computer Graphics; Flat Panel Displays

19960053058 Diehl G.m.b.H. und Co., Optoelectronics Div., Roethenbach, Germany
DIRCM: AN EFFECTIVE TECHNOLOGY FOR AIRCRAFT SELF PROTECTION AGAINST OPTRONIC MISSILE SEEKERS
Noll, M., Diehl G.m.b.H. und Co., Germany; Warm, B., Diehl G.m.b.H. und Co., Germany; Kassens, P., Diehl G.m.b.H. und Co., Germany; Jun. 1996; 16p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This report discusses the influence of the parameters of a laser system (wave length, repetition rate and output power) and the requirements for a suitable tracking system including possible ways of implementing tracking system hardware and concepts for controller loop design, for a specific engagement design of the directed infrared countermeasures (DIRCM)system for aircraft self protection against optronic missile seekers.
Derived from text
Optical Countermeasures; Laser Weapons; Eye Protection; Military Aircraft

19970010464 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
INTRODUCTION TO AVIONICS FLIGHT TEST *INTRODUCTION AUX ESSAIS DES SYSTEMES D'ARMES*
Clifton, James M., Naval Air Warfare Center, USA; Nov. 1996; 346p; In English
Report No.(s): AGARD-AG-300-Vol-15; ISBN 92-836-1045-8; Copyright Waived; Avail: CASI; A15, Hardcopy; A03, Microfiche

Modern military aircraft rely heavily on highly complex electronic systems to make them effective. These systems can compromise up to 80% of the cost of the aircraft. As new systems are developed, numerous tests are needed to provide feedback in the iterative design process and to ensure that the design parameters are met. This AGARDograph is an attempt to present the rudimentary knowledge necessary for a test pilot or engineer to develop and execute a cost effective, quick test of a modern avionics system.
Author
Avionics; Flight Tests; Airborne Radar; Cost Effectiveness; Military Aircraft; Complex Systems; Air Navigation; Electro-Optics

19970029348 Northrop Grumman Corp., Military Aircraft Systems Div., Pico Rivera, CA United States
ADVANCED AVIONICS ARCHITECTURES: WHERE ARE WE GOING?
Domae, T. P., Northrop Grumman Corp., USA; Logan, H. L., Northrop Grumman Corp., USA; Viney, J. E., Northrop Grumman Corp., USA; Advanced Architectures for Aerospace Mission Systems; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

We will explore the question of where avionics architectures are today, considering the Joint Strike Fighter and the evolution of open system approaches from the PAVE PACE and PAVE PILLAR programs of the 1980's. The recent work extends today's notions of a unified software and hardware approach to core processing and a common interconnect between architectural elements, not only to sensor or signal processing, but toward the apertures themselves and the system development environment. We shall take a broad view of the problem that includes RF electronics, interconnect, operating systems and application software development, processing hardware, and the system development environment itself. The architectural

extensions discussed here are made in the context of the basic long term technology trends of more digital sensor processing and preprocessing, higher performance analog-to-digital converters, lightwave technology for both signal distribution and routing, and software structures that reduce development expense, while increasing the supportability and portability of applications software. Future RF electronics modules will be waveform independent and support multifunction apertures in a given spectrum for a selected bandwidth, with a strong impact on affordability since the RF sensors and their associated electronics correspond to some 70 percent of avionics fly-away cost. We will show how decoupling the explicit interactions of various system elements simplifies development and system integration by removing unwanted design dependencies and providing upgrade paths for cost effective technology insertion, with minimum system breakage. These techniques will be used to implement the principles of modularity, scale up, and ability to upgrade that have become part of the today's open system approaches and will be even more important in the future as the opposite poles of capability and affordability govern both new systems and upgrades. A coherent integrated architecture that promises more affordable development, implementation, and support is presented as the answer to the question, 'Where are we going?'
Author
Computer Systems Programs; Computer Programs; Bandwidth; Avionics; Architecture (Computers); Applications Programs (Computers); Modularity; Decoupling

19970029352 Alenia Aeronautica, Turin, Italy
MODULAR AVIONICS SYSTEM ARCHITECTURE DEFINITION IN THE EUCLID RESEARCH AND TECHNOLOGY PROGRAMME 4.1: METHODOLOGY AND RESULTS
Marchetto, A., Alenia Aeronautica, Italy; Jul. 1997; 12p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The European Cooperation for Long Term in Defense (EUCLID) Research and Technology Programme (RTP) 4.1 'Modular Avionic Harmonization Study' is a joint programme carried out by France, Germany, Italy, Netherlands, Spain and United Kingdom, aiming to harmonize modular avionic concepts among the aforementioned nations, thus preparing a common European basis for the future development of modular avionics platforms, taking as reference the 2005/2010 in service date time frame. The work has been developed through five work packages, dedicated respectively to General Requirements for Modular Avionics, System Architecture Definition and Risk Assessment, Technology Programmes, Modular Avionics Support Facilities, Identification of a Roadmap for Modular Avionics. This paper presents an overview of the methodology that has been adopted to come to the definition of a modular avionic system architecture which is capable to satisfy a defined set of functional requirements, in presence of technical constraints of various nature resulting from technology assessments carried out during the programme. The paper discusses the following subjects: The different functional areas to be covered by an avionic system tailored on an envelope of operational requirements. The different categories of functional/physical elements which compose the modular system. Those requirements, among the set of driving functional requirements taken as reference in the course of the study, whose impact has been so relevant to drive or condition the architectural study. Technical requirements and constraints associated to the physical elements having a direct impact on the system architecture model. The basic characteristics and an outline of the proposed architectural model, how it has proceeded from the above functional/technical requirements, and how it incorporates important features, such as an adequate capability to tolerate faults by reconfiguration and to perform data fusion at various levels. Limits of the architectural study carried out.
Author
Functional Design Specifications; Architecture (Computers); Avionics

19970029353 Wright Lab., Avionics Directorate, Wright-Patterson AFB, OH United States
WHEN DO ADVANCED AVIONICS ARCHITECTURES MAKE SENSE FOR UPGRADING AGING AIRCRAFT?
Krueger, C. H., Wright Lab., USA; Venner, R., Wright Lab., USA; Jul. 1997; 10p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

With the dramatic reduction in defense spending in NATO countries, it is quite clear that there will be few new military aircraft for perhaps many years. A consequence is that there will be widespread use of current aircraft to satisfy future military mission requirements. One of the most cost-effective means for improving the capability of a military aircraft to deal with new threats and mission requirements is to upgrade the performance of the avionics suite. However, current federated avionics subsystems are weapon-system unique, have limited capability and life and may not support new functional requirements. In addition, the cost of performance upgrades for federated avionic suites are prohibitive, particularly in terms of the budgets available. Integrated, modular avionics technologies offer substantial potential for improving the reliability and reducing the cost/weight volume per function for adding new functional capability. Integrated, modular avionics are normally considered for new aircraft, but there is some evidence that they may have potential in some circumstances for older aircraft as well. This paper examines several military aircraft applications and discusses the circumstances where the retrofit of an advanced avionics architecture may be preferred to more conventional approaches. The major consideration is cost per function. The paper will show that the advanced architecture is a clear winner as the number of functions is significant in terms of the level of integration required with other subsystems. It is very difficult to determine with even coarse precision the costs of various approaches, but certain trends are apparent. Not too surprisingly, the dominant acquisition cost is not the avionics equipment, but the cost of installing and integrating the equipment into the aircraft together with the cost of testing, documentation and training.
Author
Avionics; Cost Effectiveness; Functional Design Specifications; Military Operations; Support Systems; Weapon Systems

19970029354 Wright Lab., Avionics Directorate, Wright-Patterson AFB, OH United States
THE FUTURE OF AVIONICS ARCHITECTURES
Morgan, D. Reed, Wright Lab., USA; Jul. 1997; 14p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A look into the future of avionic architectures over the next twenty years is presented by extrapolating past evolutionary trends, projecting future military needs and projecting the availability of advanced architectural building blocks. The basis for this forecast is drawn from the hypotheses that: (1) the physical and functional attributes of architectures evolve, even though the building block technologies often undergo revolutionary changes; hence, extrapolation of past architectural trends provides a good 'first cut' look at the future, (2) basic changes in architecture are driven by network bottlenecks resulting from the application of advanced technology building blocks that are used to improve situation awareness; hence an understanding of forces driving improvements in situation awareness and what devices future architects will have at their disposal helps frame the processing and interconnect requirements (and hence the architecture) and (3) cost containment, even cost reduction of avionics systems, will be the dominant driver for future architectures; hence, any form of physical or functional integration that reduces cost also helps define future architectures. Conclusions drawn from this paper are: (1) architecture changes resulting from avionics updates will continue to be evolutionary, with new building blocks and network designs 'grown onto' the existing infrastructure, (2) architectural extensions for retrofits will take the form of 'bridging' network interface circuitry that will interconnect advanced COTS-based networks and processors, (3) the drive for improved situation awareness will force architectures to increasingly support signal processor-based networks that will be dominated by several gigabit/second streaming data; as a result, switch-based, point-to-point links will be the primary means of system-level interconnections, with bus-based networks being used mostly for control and message passing at the backplane level, (4) for the first time, the application of new photonics-based building blocks to new avionics designs will eventually allow the avionics architect the design freedom to physically and functionally locate computing assets at space-available locations without performance penalty, (5) highly digital, 'functionally integrated, physically distributed' systems will emerge, with the co-habitation of RF analog and digital pre-processing, signal and data processing modules existing within the same module-based enclosure. A physically distributed, unified network will result, with a unified interconnect network across RF, IF, data and signal processing modules, (6) analog photonics will emerge to challenge RF electrical signal distribution,

filtering and frequency conversion functions, (7) the digital boundary will move closer to the RF apertures; digital CNI (up to 2 Ghz) systems and a mostly digital-based radar warning and radar systems will eventually replace more costly analog designs, X) within the next 15-20 years, a new 'fourth generation' architecture will emerge that will embody the features described above. The dominant feature of this projected architecture is the similar interconnect structure that both analog and digital avionics will assume. As a result of the increasing digitization of analog functions and the availability of high speed networks, the classical physical boundaries of avionics will almost vanish, (9) architectures will be driven and constrained by the mandate that designs be made open and commercial-based to the greatest extent possible. This trend will profoundly affect future architectures in that network protocols, processors and software operating systems will likely change with time. Coping with this changing environment will require the expanded use of design tools, descriptive design languages and programmable interfaces. Future architectures must be designed for change at the outset.
Author
Avionics; Architecture; Circuits; Data Processing; Digital Radar Systems; Digital Techniques; Frequency Converters; Functional Integration; Software Engineering; Protocol (Computers)

19970029355 British Aerospace Defence Ltd., Military Aircraft Div., Preston, United Kingdom
TECHNOLOGY TRANSPARENCY IN FUTURE MODULAR AVIONIC SYSTEMS
Edwards, R. A., British Aerospace Defence Ltd., UK; Connan, C., Dassault Aviation, France; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Affordability is a key driver for future weapon systems, and it is generally accepted that integrated modular avionics (IMA) can make a major contribution to the reduction of acquisition and support costs. However, the technologies upon which IMA depends are evolving rapidly, and there is a danger that emerging IMA standards and systems under development will become obsolete over timescales which are short compared to military programme lifecycles. This paper suggests that steps can be taken to mitigate the impact of obsolescence on complex avionic systems by ensuring that technology transparency is established as a key architecture characteristic, and is tackled from the outset in standardization activities and in system design. The importance of technology transparency is a consequence of the rate of technology development in relation to the long system lifecycle for military projects, and the need for interchangeability and backwards compatibility of new building blocks in 'old' systems in order to reduce life cycle costs (LCC). Examples of how technology transparency can be achieved are given for the hardware, software and data networks domains. Key areas for long term 'open system' interface standards which support technology transparency are identified, based on information previously released from the Allied Standard Avionics Architecture Council (ASAAC) standardization program. The implications of system level issues (safety, security, qualification, etc.) and the drive to exploit Commercial Off The Shelf (COTS) technology are explored, and the need to consider technology transparency for system design tools is established. The main conclusion is that, whilst many regard technology transparency as the 'Holy Grail' of IMA, practical solutions are possible in a number of areas and must be pursued vigorously through programmes such as ASAAC if LCC benefits are to be maximized.
Author
Systems Engineering; Weapon Systems; Support Systems; Life Cycle Costs; Cost Reduction; Computer Programs; Avionics

19970029356 Bundesamt fuer Wehrtechnik und Beschaffung, Koblenz, Germany
INTEGRATED MODULAR AVIONICS ARCHITECTURE CONCEPTS DEMONSTRATION
Potthaus, J., Bundesamt fuer Wehrtechnik und Beschaffung, Germany; Kloeckner, W., Elektroniksystem- und Logistik G.m.b.H., Germany; Sprang, I., Elektroniksystem- und Logistik G.m.b.H., Germany; White, C. G., Elektroniksystem- und Logistik G.m.b.H., Germany; Jul. 1997; 10p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper reports on the refinement, demonstration and validation of a number of key concepts for Integrated Modular Avionics (IMA), as performed under the IMA Demonstrator programme. For the communication network, software architecture, and fault management areas, selected aspects of the concepts were refined, and implemented on a demonstration platform. This platform, termed the IMA Demonstrator, is a tool for investigating and evaluating IMA issues, and has been constructed largely from commercial off the-shelf components. In the IMA Demonstrator, the communication network is implemented by a functional prototype of the Matrix Switched Network. The software architecture of the IMA Demonstrator includes functional prototypes of the communication system and the fault management system. The IMA Demonstrator and its functional prototypes have been used to validate the relevant IMA Concepts.
Author
Computer Systems Programs; Communication Networks; Avionics; Management Systems

19970029359 Daimler-Benz Aerospace A.G., Military Aircraft Div., Munich, Germany
SIGNATURE AVIONICS: SIGNATURE OPTIMISED OPERATING OF A STEALTH AIRCRAFT
Hurst, P., Daimler-Benz Aerospace A.G., Germany; Knappe, P., Daimler-Benz Aerospace A.G., Germany; Benninghofen, B., Daimler-Benz Aerospace A.G., Germany; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Stealth design is one design principle for next generation combat aircraft. The effort in this area have a long history at the Daimler-Benz Aerospace (Dasa), formerly MBB, e.g. the Lampyridae project in the early 80's. Operational studies have shown that the introduction of stealth design will increase the survivability of combat aircraft significantly, especially against airborne threats. Yet the effective use of critical signatures during a mission and the matching of tactics to stealth features require the development of an adapted avionics. This adapted avionics - signature avionics - will not compromise the stealth design, take direct advantage from the stealth characteristics, and utilize the stealth properties via an integrated tactical mission control. to transform this idea into an applicable format suited for the implementation in aircraft avionics systems, a functional breakdown in individual functions, prototyping and performance analysis of these functions, turns out to be necessary. The feasibility of this approach has been proven on the signature avionics function 'fly by signature' as an example.
Author
Reliability Analysis; Fighter Aircraft; Avionics

19970029360 Naval Air Warfare Center, Aircraft Div., Warminster, PA United States
A MULTISERVICE SWITCH FOR ADVANCED AVIONICS DATA NETWORKS
Rosen, W. A., Naval Air Warfare Center, USA; Phipps, W. A., Florida Agricultural and Mechanical Univ., USA; George, A. D., Florida Agricultural and Mechanical Univ., USA; Turner, D. D., Naval Air Warfare Center, USA; Gershman, V., Naval Air Warfare Center, USA; Birmingham, M. P., Naval Air Warfare Center, USA; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

With knowledge of persistent data communication traffic patterns offered to an avionics data network, modifications to the routing through the network can be made to improve total throughput and bound the latency of packets. The Multiservice Switch (MSS) is such a route-optimizing switch for streaming sensor data. The MSS has two switching fabrics. packet switching and circuit switching. The packet-switching fabric routes small control and data packets between switch ports. The circuit-switching fabric uses a crossbar to physically connect ringlets, which reduces the workload on the packet-switching fabric long data streams between the ports. An implementation of the MSS is described which uses commercial-off-the-shelf (COTS) components. A simulation model was developed to show the benefits of the MSS under standard avionics workloads. The results of the MSS indicate distinct advantages in terms of performance, price, and power consumption over other conventional switch and network topology designs.
Author
Switching Circuits; Topology; Switches; Routes; Packets (Communication); Packet Switching; Data Transmission; Data Flow Analysis; Computer Networks; Avionics

19970029361 National Aerospace Lab., Amsterdam, Netherlands
SIMULATION OF A CELL SWITCHED NETWORK FOR THE CONTROL OF A SWITCH MATRIX IN A HIGH-SPEED AVIONICS NETWORK
Aupers, David A., National Aerospace Lab., Netherlands; Heerink, Gerald J., National Aerospace Lab., Netherlands; Wellink, Steven, National Aerospace Lab., Netherlands; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper describes the research and experiments carried out by the National Aerospace Laboratory (NLR) in the field of high-speed interconnection systems for modular avionics. The research has been carried out in the EUCLID/RTP4.1 framework. The avionics network that was modelled and simulated was an optical switch matrix under control of a cell switched network. The optical switch matrix offers the avionics system circuit switched, uni-directional, point-to-point connections. A bandwidth of 2 Gbps is projected. The main purpose of the matrix is to connect sensors producing high data rates, such as an attack radar in fighter aircraft, with the core avionics processing cluster. The cell switched network - in this case Asynchronous Transfer Mode (ATM) - controls the optical switch matrix and provides data transfer at lower data rates, file transfer, and status messages. The simulation model operated ATM at 149 and 622 Mbps. The primary objective of our research was to assess ATM as a data link layer for a control and message network in an avionics data network. The computer-based tool to model the network was SES/Workbench.
Author
Asynchronous Transfer Mode; Avionics; Bandwidth; Computer Networks; Data Links; Network Control; Switching Circuits

19970029364 Hughes Aircraft Co., Los Angeles, CA United States
INTEGRATED PROCESSING
Farmer, Roy, Hughes Aircraft Co., USA; Robinson, Thomas H., Hughes Aircraft Co., USA; Trujillo, Edward, Hughes Aircraft Co., USA; Jul. 1997; 10p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A review of the modular avionics concepts is presented in light of DOD's mandate to change the military's acquisition process and the recent delivery of advanced modular processing systems developed to meet the demands of the next generation avionics. Future trends - in avionics are discussed along with how this will impact the modular standards just now being implemented. Modular avionics is the most dominant feature of our advanced avionics systems. Initially mandated because of the projected cost advantages, modular avionics also provides significant performance potential. Modular avionics is characterized by configurations that partition the system into building blocks that feature integration, modularity, and commonality. The main focus of these concepts is initially being applied to the digital core avionics for which the F-22 Common Integrated Processor is a powerful and innovative realization. The USAF PAVE PACE and NASA programs extended the current concepts further and the initiatives to integrate commercial-off-the-shelf (COTS) technology has fostered innovative solutions to improve increased availability at reduced costs. Functions within the aircraft will become more integrated requiring innovative approaches to the management of the computer resources and distribution of information.
Author
NASA Programs; Modularity; Cost Reduction; Avionics; Computers

19970029365 Daimler-Benz Aerospace A.G., Sensor Systems, Ulm, Germany
A MODULAR SCALEABLE SIGNAL PROCESSOR ARCHITECTURE FOR RADAR AND EW APPLICATIONS
Keller, H. P., Daimler-Benz Aerospace A.G., Germany; Rabel, R., Daimler-Benz Aerospace A.G., Germany; Schmitt, K.-P., Daimler-Benz Aerospace A.G., Germany; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Daimler-Benz Aerospace, Ulm has developed the Advanced Programmable Signal Processor (APSP), a modular, scaleable and programmable multi-Gigaflop machine based on studies sponsored by GMOD. The modular architecture allows an easy tailoring to quite different requirements in signal processing and pattern recognition for Radar, Sonar, Electro-optical sensor applications, e.g. from small non-coherent radar and EW systems up to sophisticated airborne multi-mode pulse doppler radars or complex ground or ship based multi-channels radars. From an architectural point of view, the APSP comprises clusters of single chip floating point processors (Texas Instruments TMS320C3x [1] digital signal processor which can perform 32-bit floating point calculations at a 60 Megaflop rate), special partially programmable modules (based upon off-the-shelf VLSI-chips), multipurpose memory modules and multipurpose interface modules. The APSP comes with comprehensive Software and Tools including the real time multiprocessor operating system APOS. The modularity and scalability in Hardware and Software offers the possibility to tailor the signal processor performance to the application, while preserving options for growth potential. Furthermore modifications in the processing algorithms are done via software changes, without costly hardware redesign. This article focuses the major aspects of the APSP in Hardware, Operating System and Software Tools and shows the implementation of a small and a high performance application.
Author
Modularity; Algorithms; Coherent Radar; Computer Programs; Digital Systems; Doppler Radar; Electro-Optics; Radar Detection; Signal Analyzers

19970029373 Elektroniksystem- und Logistik G.m.b.H., Avionics-Fixed Wing Aircraft, Munich, Germany
SENSOR FUSION FOR MODERN FIGHTER AIRCRAFT
Taubenberger, K., Elektroniksystem- und Logistik G.m.b.H., Germany; Ziegler, J., Daimler-Benz Aerospace A.G., Germany; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Sensor Fusion has become important for fighter aircraft in order to improve the air picture with respect to the displayed area of all sensors, the precision of target's kinematic data, the confidence in the target's identity, and to support the management of the sensors. The paper investigates system architectures of existing and future sensors. Based on a Bayesian fusion approach, the benefits and constrains of data throughput, accuracy and track consistency is shown. The results of simulation runs with radar, IR and ESM sensor models together with a data link network are presented.
Author
Bayes Theorem; Fighter Aircraft; Multisensor Fusion; Images; Data Links

19970029374 Wright Lab., Wright-Patterson AFB, OH United States
IMPACT OF COTS ON MILITARY AVIONICS ARCHITECTURES
Carbonell, Juan, Wright Lab., USA; Ostgaard, John, Wright Lab., USA; Jul. 1997; 6p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Department of Defense is being driven to use Commercial Off-the-Shelf (COTS) hardware and software in order to reduce the overly complex and unnecessary practices of using military standards and specifications while reducing costs. There are a variety of issues related to the use of COTS hardware and software components in military avionics systems that have an impact in the architectures. Avionics packaging, cooling, networks, processors, and software languages are just a sample of the areas affected by the use of COTS. A number of steps must be taken by weapon systems managers to ensure they have a strategy in place to meet the challenges brought on by COTS technologies.
Author
Computer Programs; Avionics; Defense Program; Systems Management; Weapon Systems

19970029375 Daimler-Benz Aerospace A.G., Military Aircraft Div., Munich, Germany
AN APPROACH TOWARDS INTEGRATION OF A MODULAR CORE AVIONICS SYSTEM KERNEL
Grasshoff, M., Daimler-Benz Aerospace A.G., Germany; Foerster, M., Daimler-Benz Inter Services, Germany; Jul. 1997; 14p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Daimler-Benz Aerospace (Dasa) Military Aircraft Division has set up an experimental avionic system with modular structure using VMEbus based hardware components and a commercially available operating system (OS) as common OS. Since commercially available realtime OS's do not fulfill the requirements for future avionic systems, System Management Software (SYMS) has been developed. SYMS enables the communication between different processor modules and

their co-operation. This is the presupposition for fault management and reconfiguration management within the whole core system. The reconfigurability of the experimental system has been demonstrated. The source code of SYMS has been fully written in Ada. Small sized interfaces to the hardware and to the OS support easy adaptation to different environments of hardware and or OS. Applications of the whole core system are controlled separately by SYMS Tables (Blueprints). The approach supports developing portable and reusable application software. The flexibility of SYMS enables the demonstration of different standards and their capabilities within different integrated systems. Currently, this work is of interest in view of the Allied Standard Avionics Architecture Council (ASAAC) demonstration programme, planned for the ASAAC Phase 2. Flight capable derivatives of the experimental system can be used in different experimental flight programmes. Information about a modular computer to be flown within an experimental flight programme is presented.
Author
Ada (Programming Language); Applications Programs (Computers); Avionics; Computer Programs; Kernel Functions; Real Time Operation; Systems Management

19970029376 Daimler-Benz Aerospace A.G., Hamburg, Germany
LOW-LEVEL FLIGHT CAPABILITY OF A FUTURE MILITARY TRANSPORT AIRCRAFT BASED ON COMMERCIAL AVIONICS
Kricke, K. Dieter, Daimler-Benz Aerospace A.G., Germany; Schaefer, Dirk, Daimler-Benz Aerospace A.G., Germany; Jul. 1997; 10p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

There is a need for a new military transport aircraft, which can cope with the operational requirements to improve the current air transport forces of the European countries to satisfy tactical, logistic and future operations, at the beginning of the next century. Significant requirements, which relate to the avionics and mission systems, are for instance: low-level flight capability and board-autonomous approach and landing capability enabling adverse weather operations by day and night. This paper describes a system concept for low-level flight capability based on commercial avionics as used in AIRBUS aircraft. First, the essential functions and features of the flight control and flight guidance system are highlighted. Then, the additional functions and system elements related to controls/displays and operational modes, which are required for low-level flight, are discussed. Finally, the first results of a demonstration and pilot evaluation performed in the flight simulator a DAIMLER-BENZ AEROSPACE AIRBUS in Hamburg are presented. The investigations described in this paper have been performed within the context of technology studies, which are partially sponsored by the German Ministry of Defence.
Author
Air Transportation; Avionics; Display Devices; Flight Control; Flight Simulators; Transport Aircraft

19980016583 Sextant Avionique, Velizy-Villacoublay, France
IMPACT OF NEW INFORMATION TECHNOLOGY AND MICRO-TECHNIQUES ON AVIONICS FUNCTIONS AND STRUCTURES
Loise, Dominique, Sextant Avionique, France; Lacroix, Jean-Paul, Thomson-CSF, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 6p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The avionics functions of the 70s and 80s had a growth rate of their embedded processing resources consistent with the progress pace of the semiconductors technology. The avionics functions designed in the early 90's were impacted by information technology, LCC and availability requirements; they are enlightened by the shift from federated to integrated avionics architectures. The micro-techniques, which allow to combine analog sensing and/or actuating with local processing and communication resources, combined to the new trends of information technology in networks (client/server architectures), and the steady increase of semi-conductors technology, may initiate the move of the integrated avionics functions to the distributed micro-systems. These micro-techniques and their application fields are briefly described and their impacts on the architecture and functions are estimated. Some results come from advanced development of the Radar of the next generation, based on Active Array Antenna. Preliminary conclusions are that commercial technology (COTS, Software tools, digital processing, communication protocols) will be usable; an aggregated increase of the communication requirements has to be expected from the distribution of the sensors all over the platform but placing the boundaries at the wrong place while distributing the system may actually worsen the communication issues, as some management and fusion/ consolidation processing resources will have to remain centralized, notwithstanding potential exchanges between the distributed elements. These communication constraints, together with the cooling and power supply distribution issues, remain challenges that the avionics community would have to solve by itself.
Author
Information Systems; Avionics; Technology Assessment; Microinstrumentation; Semiconductor Devices; Aircraft Instruments; Radar Detection

19980033532 Naval Air Warfare Center, Weapons Div., China Lake, CA United States
MODERN FIGHTER MISSION AVIONICS: THE JOINT STRIKE FIGHTER AVIONICS ARCHITECTURE
Lachenmaier, Ralph, Naval Air Warfare Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 8p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Joint Strike Fighter (JSF) program is potentially the largest new military aircraft program in the world today. A preliminary avionics architecture has been defined and published. Several efforts are underway to prototype and demonstrate various aspects of that architecture. The architecture will be refined and updated between now and the beginning of Engineering and Manufacturing Development (EMD) expected to begin in 2001. This paper describes the avionics architecture in its current state, discusses the motivation behind the various areas of the architecture, presents the issues involved, and discusses the results of some of the demonstration efforts. The JSF program is based on the four pillars: affordability, lethality, survivability, and supportability. First and foremost among the pillars is affordability. In order to field a lethal, supportable, survivable aircraft, affordability tradeoffs will be conducted by the prime contractors. Historically, 30-40 percent of weapons system life cycle costs have been attributed to avionics, hence reduction in avionics systems costs are essential in satisfying JSF pillar requirements. An F-22 technology point-of-departure has been used to baseline the avionics architecture planning. The JSF is leveraging that significant technology investment, conducting maturation of new contributing technologies, and implementing, where appropriate, COTS components, standards, and processes to enhance affordability of the next generation strike fighter.
Derived from text
Avionics; Fighter Aircraft; Product Development; Cost Reduction; Lethality; Military Aircraft

19980035008 Flight Test Squadron (40th), DOOB, Eglin AFB, FL United States
AGM-130 IMPROVED MODULAR INFRARED SENSOR (IMIRS) FLIGHT TEST
Corej, Thomas A., Flight Test Squadron (40th), USA; Kosan, Keith J., Flight Test Squadron (40th), USA; Advances in Flight Testing; Dec. 1997; 8p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The AGM-130/Improved Modular Infrared Sensor (IMIRS) weapon system is operationally compatible with the F-15E and F-111F launch platforms. The addition of a rocket motor to the GBU-15, making it an AGM-130, increases the standoff range of the AGM-130. The IMIRS seeker is an InfraRed (IR) seeker for the AGM-130, and the AGM-130/IMIRS system provides sufficient resolution for target detection in day or night. Using a two-ship scenario (one weapon-carrying aircraft and one controlling aircraft), the controlling aircraft can stand off at an extended classified range and successfully guide the weapon to impact. The aimpoint update feature of the IMIRS seeker allows for small changes to be made in the aimpoint allowing for precisely attacking a specific point on a target. When the Weapon

Systems Officer (WHO) locks-on to a target, he can slew to refine the Desired Mean Point of Impact (DMPI) and then lock-on to the new DMPI without breaking the lock on the original aimpoint.
Author
Infrared Detectors; Flight Tests; Infrared Radiation; Target Acquisition

19980035016 Royal Netherlands Air Force, Leeuwarden, Netherlands
A DATA ACQUISITION SYSTEM FOR THE RNLAF MLU F-16 REQUIREMENTS AND PROPOSAL
Koolstra, H. J., Royal Netherlands Air Force, Netherlands; Hollestelle, P. M. N., National Aerospace Lab., Netherlands; Klijn, J. M., National Aerospace Lab., Netherlands; Advances in Flight Testing; Dec. 1997; 6p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In 1983 the Royal Netherlands Air Force (RNLAF) requested the National Aerospace Laboratory NLR to design, procure and install a flight test data acquisition system to be used with the F-16 fighter aircraft. The design was heavily based on the systems, which were at that time nearing their completion for flight tests with Fokker aircraft. The system was delivered to the RNLAF in 1984 and has been continuously in use since that time. With the coming introduction of the Mid-Life Update programme of the F-16, it was foreseen that the current system would not be able to fulfill its tasks anymore. The RNLAF together with NLR draw up the requirements for a new data acquisition system. A proposal for the new system was made by NLR, again based on recent developments of flight test instrumentation for Fokker aircraft, but also with future developments in the field of airborne flight test instrumentation in mind. In this paper the requirements for the new system will be given. The proposed system will be described by means of a general concept. Although the final implementation of this general concept is not decided upon yet, the benefits and drawbacks of a possible implementation, based on the Common Airborne Instrumentation System standards, are discussed. It is concluded that there is a preference for this implementation, provided the tight time schedule can be met.
Author
Data Acquisition; F-16 Aircraft; Flight Test Instruments; User Requirements; Airborne Equipment

19980035028 Defence Evaluation Research Agency, Farnborough, United Kingdom
TORNADO INTEGRATED AVIONICS RESEARCH AIRCRAFT (TIARA)
Brown, A. D., Defence Evaluation Research Agency, UK; Stocks, A. J., Defence Evaluation Research Agency, UK; Dec. 1997; 10p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The paper describes the role, major features and flight trials programme of the Tornado Integrated Avionics Research Aircraft (TIARA). This significantly modified F2A(T) Tornado, ZD902, is the flagship of the trials fleet currently operated by the Defence Evaluation and Research Agency (DERA), an Executive Agency of the UK Ministry of Defence. TIARA is a multi-sensor, multi-role trials facility intended to demonstrate a "total systems integration" concept. It not only directly supports military customer programmes but also has sufficient capacity for collaborative programmes with other research organisations. Following a major conversion programme, ZD902 is now currently being used for the evaluation of IR sensors and helmet mounted displays. The future installation of the Blue Vixen AI radar will complete TIARA as a research facility and allow trials on sensor data fusion to begin.
Author
Avionics; Flight Tests; Research Aircraft; MRCA Aircraft

19990007847 Boeing Co., Anaheim, CA United States
SENSOR ALTERNATIVES FOR FUTURE UNMANNED TACTICAL AIRCRAFT
Fleeman, E. L., Boeing Co., USA; Jul. 1998; 16p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper addresses the enabling technologies of the sensor suite for the next generation Unmanned Tactical Aircraft (UTA). An assessment is made of target sensors, communication sensors, and navigation sensors that are used in the UTA intelligence, surveillance, reconnaissance, communication, and target designation missions. Emphasis is given to the classes of UTAs that operate at stand-off altitudes and ranges outside the effectiveness envelope of typical threat air defenses and jammers. Primary environmental factors that are addressed in the paper are world-wide cloud cover and rain rate. The effects of cloud cover and rain rate on sensor performance are evaluated for synthetic aperture radar (SAR), passive millimeter wave (mmW), and electro-optical (EO) sensors. The synergy of radar frequency (RF) sensors to improve the sensor suite performance in cloud cover and rain rate is addressed. The paper also addresses the enabling technologies that are required for real time, low false alarm rate (FAR), automatic target recognition (ATR) and precision targeting. A target sensor suite is postulated that is based on multi-spectral, multi-dimension discriminants of the target. An X-band or Ku-band SAR is considered to be the best overall target sensor for UTA applications. A priority ranking of other target sensors is ultra wide band (UWB) low frequency SAR, forward looking infrared (FLIR), laser infrared detection and ranging (LIDAR), visible, and passive mmW. The Year 2007 sensor suite would cover the multi-spectral range of VHF frequency to visible wavelength and the multi-dimensional parameters of contrast, two-dimensional shape, three-dimensional shape, temporal, and polarization signatures of the target.
Author
Pilotless Aircraft; Sensors; Target Acquisition; Target Recognition; Synthetic Aperture Radar; Radar Targets; Real Time Operation

19990014367 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
ADVANCED INFORMATION PROCESSING AND DISPLAY TECHNOLOGIES
Timmers, H., Advisory Group for Aerospace Research and Development, France; Helps, K., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 68; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

These technologies; High speed processing, flat panel high resolution displays, voice activation, optical processing/networking, and helmet mounted displays; are mainstream enabling technologies for today's aircraft and/or aircraft now in development. It is not expected that the performance of subsystems based on them will be of adequate performance to cope with increased information availability, 24-hour availability and higher performance sensors. Specifically: High speed processing improvements, deriving from commercial components, will need to be available for increased data processing. Flat panel (color) high resolution displays in large sizes, eg. 30" x 12" will need to be adapted from, e.g. low cost field emission displays (FEDs) developed for commercial reasons in different aspect ratios, to provide an effective means for pilot situation awareness. Voice activation will allow the pilot to operate on a broader front with displays and controls, in high workload or high-g environments, and the military requirements will not be totally covered by commercial developments, e.g. in voice environment robustness. Optical processing/networking is an enabling technology for integrated modular avionics. Helmet mounted displays technology is still deficient in performance, head weight, integration with designation and head down displays.
Derived from text
Display Devices; Voice Control; Optical Data Processing; Helmet Mounted Displays

19990014369 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
FAULT TOLERANT HIGHLY INTEGRATED AVIONICS ARCHITECTURES
Timmers, H., Advisory Group for Aerospace Research and Development, France; Ott, L., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 73-74; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Avionics is approaching 40% of the weight and cost of the aircraft. In order to reduce weight, cost and maintenance actions and provide affordably increased functionality, a highly integrated commercial-off-the-shelf (COTS) based avionics architecture must be developed. This architecture will be characterized by its modularity, resource sharing, fault tolerance attributes and wide use of commercial components. The overall dependability and fault tolerance of the next generation of highly integrated, COTS based avionics systems will be a critical factor in the effectiveness of those systems in future combat

scenarios. Thus the challenge is to demonstrate and validate that this high integration and the military real-time, fault tolerant and security requirements can be met with CTS/open system components.
Derived from text
Avionics; Systems Integration; Aircraft Instruments; Military Technology

07
AIRCRAFT PROPULSION AND POWER

19960008173 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
RECOMMENDED PRACTICES FOR THE ASSESSMENT OF THE EFFECTS OF ATMOSPHERIC WATER INGESTION ON THE PERFORMANCE AND OPERABILITY OF GAS TURBINE ENGINES *RECOMMANDATIONS CONCERNANT LES METHODES A UTILISER POUR LE TRAITEMENT DE LHUMIDITE DANS LES TURBINES A GAZ*
Sep 1, 1995; 364p; In English
Report No.(s): AGARD-AR-332; NIPS-95-06172; ISBN 92-836-1022-9; Avail: CASI; A16, Hardcopy; A03, Microfiche

The ingestion of water from the atmosphere into the inlet of a gas turbine can significantly influence the performance and operability of the engine. The objective of this report is to identify preferred practices to measure the effect of water ingestion on engine performance and operability. Atmospheric water is considered in all its forms; gaseous humidity, condensation droplets, rain, snow, and hail. The Introduction to Chapter 1 summarizes the purpose and background to the report and identifies the intended audience. Chapter 2 provides a quantitative assessment of the hazardous weather threat due to water for all types of aircraft using data collected from international sources. Chapters 3, 4, and 5 examine analytical and experimental techniques currently in use to measure and to predict the effects of the different forms of ingested water on engine performance and operability. Chapter 6 summarizes current acceptance and certification specifications used by different national agencies in assessing the effects of ingested water. In Chapter 7 a review is made of current instrumentation used to assess and quantify the presence of vapor, liquid droplets, and particles (frozen droplets) in the flow. Chapter 8 describes briefly current methods for testing gas turbine engines under typical weather threat conditions. The final chapter of the report summarizes the collected information on the effects of water ingestion from the preceding chapters and presents a set of conclusions and recommendations for future research.
Author
Atmospheric Moisture; Condensation; Drops (Liquids); Engine Inlets; Flight Hazards; Gas Turbine Engines; Ingestion (Engines); Performance; Water Vapor

19960021124 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
THERMAL MECHANICAL FATIGUE OF AIRCRAFT ENGINE MATERIALS *LA FATIGUE THERMOMECANIQUE DES MATERIAUX CONSTITUTIFS DES MOTEURS D'AVION*
Mar. 1996; 236p; In English; 81st Meeting of the AGARD Structures and Materials Panel, 2-4 Oct. 1995, Banff, Canada; See also 19960021125 through 19960021145
Report No.(s): AGARD-CP-569; ISBN 92-836-1031-8; Copyright Waived; Avail: CASI; A11, Hardcopy; A03, Microfiche

Aircraft engine components experience severe operating conditions, often involving complex combinations of cyclic mechanical stress, cyclic temperature and varying environmental conditions. At the 81st meeting of the AGARD Structures and Materials Panel,the SMP held a Specialists' Meeting on Thermal Mechanical Fatigue of Aircraft Engine Materials to review the state-of-the-art experience in experimental methods as well as approaches to analytical modelling of damage accumulation and growth in metallic gas turbine engine materials under TMF conditions.
Author
Thermal Fatigue; Aircraft Engines; Engine Parts; Damage; Cracking (Fracturing); Thermal Stresses

19960021125 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Materials and Processes Dept., Evry, France
THERMOMECHANICAL FATIGUE IN GAS TURBINE ENGINES: THE REASONS OF A CONCERN
Lasalmonie, A., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Pellerin, F., Turbomeca S.A. - Brevets Szydlowski, France; Fournier, D., Turbomeca S.A. - Brevets Szydlowski, France; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 6p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The improvement of the performance of gas turbine engines for military aircrafts or helicopters has been the result of a continuous evolution in the materials properties and the technology of the components. The result of this evolution is that the alloys experience complicated stress and temperature cycles; the life prediction based on isothermal characterization is no longer satisfactory. Classic isothermal tests do not discriminate enough for behavior validation and are sometimes unrealistic to describe damage mechanisms. In the case of the helicopter engines, technological evolutions contributed also to more severe temperature gradients. This paper presents in more detail the thermomechanical fatigue (TMF) concerns on the components which are submitted to the highest temperatures.
Derived from text
Thermal Fatigue; Engine Parts; Stress Cycles; Gas Turbine Engines; Thermal Stresses; Turbine Blades

19960021126 General Electric Co., Schenectady, NY United States
TMF EXPERIENCE WITH GAS TURBINE ENGINE MATERIALS
Cook, T. S., General Electric Co., USA; Laflen, J. H., General Electric Co., USA; VanStone, R. H., General Electric Co., USA; Wright, P. K., General Electric Co., USA; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 16p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Standard design and analysis methods for determining fatigue life involve using fatigue data generated under isothermal conditions. The large temperature variations in the turbine section of gas turbine engines promote an interest in the effect of temperature cycling on fatigue life. Consequently, thermomechanical fatigue (TMF) tests have been conducted on a variety of materials to determine the effects of temperature cycling on fatigue crack initiation and growth. This paper reviews enhanced test methods, the results of such tests, life prediction methods, and makes recommendations for future work.
Author
Engine Parts; Gas Turbine Engines; Thermal Fatigue; Fatigue Tests; Fatigue Life; Crack Initiation; Crack Propagation

19960021127 Wright Lab., Aero Propulsion and Power Directorate., Wright-Patterson AFB, OH United States
THERMAL MECHANICAL FATIGUE AND ITS EFFECT ON COMBUSTOR DESIGN
Sikorski, R. L., Wright Lab., USA; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 4p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

In the past, a typical combustor design consisted of single-wall 360 degree rings with film cooling introduced periodically along the length of the combustor wall. This type of construction coupled with dilution and cooling hole discontinuities, created high local thermal stresses. The pressure levels also affected the radiation such that as pressure increased, thermal gradients and thus thermal stresses increased. Mechanical loads and stresses were directly proportional to the pressure loading in the combustor. The combination of these thermal and mechanical stresses caused premature failures in the combustor liners. Evidence indicates that dividing components into segments reduces mechanical load and thermal variations significantly. Combustor liner segments are supported by a load bearing structure such that pressure levels have a small effect on the segmented liner. These segments can also grow both axially and circumferentially, thus reducing thermal gradients in the liner. The resulting reduction in stress lowers the possibility of a catastrophic

failure in the component. The purpose of this paper is to trace the history of segment combustors, examining their role in today's technology, and to explore development for the future.
Author
Thermal Stresses; Combustion Chambers; Engine Design; Thermal Fatigue; Linings

19960021133 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry, France
DAMAGE MECHANISM ASSESSMENT ON TURBINE BLADES SUPERALLOYS THROUGH TMF TESTS
Lautridou, J. C., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Guedou, J. Y., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Delautre, J., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 6p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The greatest advance in metal temperature and stress capability for turbine blades in the last 30 years has been the result of the development of directionally solidified single crystal superalloys. Two groups of alloys, called first and second generation, have been developed. The second generation alloys were essentially developed to improve the creep resistance and the long time phase stability in order to allow increased operating temperatures. Creep resistance is not the only property to be considered for life prediction. In complex shaped highly cooled turbine blades, stresses of thermomechanical origin may become at least as important as the centrifugal stress causing the creep of the material during the stabilized regime of the engine cycle. Those thermomechanical stresses are generated in particular during aircraft take off and landing operations. A limited amount of work has been done to compare the performance of the two generations of single crystal alloys regarding thermomechanical fatigue resistance. The aim of the present study was to compare the mechanical properties of four single crystal superalloys belonging to the first (AM1, AM3) and second generation (MC2, CMSX4). In order to get a complete comparison, creep rupture, and thermal mechanical fatigue (TMF) tests were carried out.
Derived from text
Thermodynamic Properties; Damage Assessment; Thermal Fatigue; Turbine Blades; Heat Resistant Alloys; Fatigue Tests; Creep Strength; Crack Initiation; Crack Propagation

19960021137 Central Inst. of Aviation Motors, Moscow, Russia
DAMAGE MECHANISMS FOR THERMOMECHANICAL FATIGUE OF AIRCRAFT ENGINES MATERIALS
Nozhnitsky, Yu. A., Central Inst. of Aviation Motors, Russia; Doulnev, R. A., Central Inst. of Aviation Motors, Russia; Soudyrin, V. G., Central Inst. of Aviation Motors, Russia; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 12p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

There are presented the main lines of the conducted in CIAM investigations of thermomechanical fatigue of aircraft engine parts materials. Based on a generalization of the results of extensive experimental investigations, it is suggested the strength criterion for non-isothermal cyclic loading with creep effect in every cycle involving two limiting characteristics: value of the limiting material deformation, determined in the conditions of single-cycle reverse loading at temperature changing by the T(min) approaching T(max) approaching T(min) regime; and value of limiting creep strain determined in the cyclic creep conditions. The analytical methods for determining a stress-strain state and the approaches for estimating a life in case of thermomechanical loading of turbine SC-alloy blades and coated blades are worked out.
Author
Creep Properties; Stress-Strain Relationships; Thermodynamic Cycles; Thermal Stresses; Thermal Fatigue; Temperature Gradients; Fatigue Life; Turbine Blades

19960021139 Defence Research Agency, Pyestock, United Kingdom
MODELLING OF THERMOMECHANICAL FATIGUE IN AERO ENGINE TURBINE BLADES
Harrison, G. F., Defence Research Agency, UK; Tranter, P. H., Defence Research Agency, UK; Williams, S. J., Rolls-Royce Ltd., UK; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 12p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The paper discusses the major parameters influencing the design of aero engine high pressure turbine blades and their contribution to the thermomechanical fatigue (TMF) behavior of these blades. Procedures for calculating transient temperatures and the role of such temperatures in determining thermomechanical stresses are considered. In turn, having established the major parameters influencing the TMF behavior of the blade, both stress and strain based life prediction models are considered. In-phase and out-of phase TMF test results of both plane and coated specimens are presented and the implications for lifting models are discussed. Finally, the form of future TMF models are briefly considered.
Author
Aircraft Engines; Turbine Blades; Life (Durability); Stress-Strain Relationships; Thermal Fatigue; Thermal Stresses; Fatigue Life; Performance Prediction; Prediction Analysis Techniques

19960024804 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
LOSS MECHANISMS AND UNSTEADY FLOWS IN TURBOMACHINES *LES MECANISMES DES PERTES ET LES ECOULEMENTS INSTATIONNAIRES DANS LES TURBOMACHINES*
Jan. 1996; 578p; In English; In French; 85; Propulsion and Energetics Panel Symposium, 8-12 May 1995, Derby, UK; See also 19960024805 through 19960024846; Original contains color illustrations
Report No.(s): AGARD-CP-571; ISBN 92-836-0020-7; Copyright Waived; Avail: CASI; A25, Hardcopy; A06, Microfiche

The Conference Proceedings contains 42 papers presented at the Propulsion and Energetics Panel 85th Symposium on Loss Mechanisms and Unsteady Flows in Turbomachines which was held from 8-12 May 1995, in Derby, UK. Sessions: Cascade Steady Flow Mechanisms and Losses (9 papers); Steady Flow Clearance and Injection Flow Mechanisms and Losses (6); Steady Secondary Flows and Shock Boundary Layer Interaction (3); Blade Section-Wake Boundary layer Interaction (6); Management of Unsteady Flows (10); Blade Interactions (8). The Symposium contributes to improving the efficiency and operation of turbomachinery also in off-design conditions by application of experimental and computational fluid dynamics methods. Multi-stage methods and positive loss management in the design stage have been identified as next steps. This will yield optimized engines of high efficiency for expanded flight envelopes including active control of the plane movement at high reliability levels.
Author
Computational Fluid Dynamics; Boundary Layer Transition; Shock Layers; Engine Design; Aircraft Engines; Turbomachinery

19960024805 Technische Univ., Inst. of Fluid Mechanics., Brunswick, Germany
ENDWALL BOUNDARY LAYER SEPARATIONS AND LOSS MECHANISMS IN TWO COMPRESSOR CASCADES OF DIFFERENT STAGGER ANGLE
Stark, U., Technische Univ., Germany; Bross, S., KSBAG, Germany; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 16p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The paper describes experimental and theoretical investigations on the effect of stagger angle on the endwall flow in two compressor cascades, one with a low stagger angle (1 = 30 degrees) and one with a high stagger angle (1 = 50 degrees). The results of flow visualization tests, wake measurements and inviscid secondary flow calculations are shown for both cascades. The more important differences between the two sets of results are discussed with particular attention to 3D endwall boundary layer separations and loss mechanisms.
Author
Cascade Flow; Flow Visualization; Wall Flow; Boundary Layer Flow; Wakes

19960024806 National Technical Univ., Lab. of Thermal Turbomachines., Athens, Greece
LOSSES PREDICTION IN AXIAL FLOW COMPRESSOR CASCADES USING AN EXPLICIT K-EPSILON NAVIER-STOKES SOLVER
Vassilopoulos, C., National Technical Univ., Greece; Simandirakis, G., National Technical Univ., Greece; Giannakoglou, K. C., National Tech-

nical Univ., Greece; Papailiou, K. D., National Technical Univ., Greece; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 10p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

Flow patterns and losses prediction in a controlled diffusion airfoil cascade of an industrial axial compressor are demonstrated by means of a two-dimensional, explicit, time-marching fractional-step solver. The fractional-step algorithm presents certain advantages which are mainly related to its simplicity and the fact that greater time-steps are allowed, in comparison to other explicit solvers. In the present analysis, turbulence is modeled through both a low Reynolds k-E model and the algebraic Baldwin-Lomax one. The former is combined with an efficient artificial viscosity scheme, leading thus to a smooth E-field close to the solid walls. From a numerical point of view, the Baldwin-Lomax model cooperates perfectly with the basic numerical kernel. The k-E model, when used in conjunction to an explicit solver, is prone to instabilities and a particular semi-implicit treatment of the source terms is required. On the basis of the examined cases, differences in the predictive capabilities of the two turbulence models are presented and discussed.

Author

K-Epsilon Turbulence Model; Navier-Stokes Equation; Turbocompressors; Flow Distribution; Cascade Flow; Kernel Functions

19960024807 Manchester Coll. of Science and Technology, Dept. of Mechanical Engineering., United Kingdom

COMPUTATIONAL MODELLING OF CASCADE-BLADE FLOW WITH LINEAR AND NON-LINEAR LOW-RE EDDY-VISCOSITY MODELS

Chen, W. L., Manchester Coll. of Science and Technology, UK; Lien, F. S., Manchester Coll. of Science and Technology, UK; Leschziner, M. A., Manchester Coll. of Science and Technology, UK; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

A computational study is presented of the flow around a controlled-diffusion compressor-cascade blade at design as well as off-design conditions. In this flow, features associated with by-pass transition close to the leading edge - probably including laminar leading-edge separation contribute significantly to the evolution of the boundary layer on the blade surface. This has motivated the additional investigation of transition in a number of flows which are highly pertinent to the principal blade flow: two flat-plate boundary layers, a flow over a curved blade-like bump in a channel, and a flow past a rounded leading edge involving laminar separation and transitional reattachment. It is demonstrated that conventional eddy-viscosity models, based on the linear Bousinesq stress--strain relations, are able to capture by-pass transition in simple shear, but are unable to resolve transitional features in complex strain, especially those associated with leading edge separation, unless a mechanism is introduced to suppress excessive normal-strain-induced production of turbulence energy. The non-linear model is shown to return a considerably improved representation of the blade flow, resolving the leading-edge processes and returning a much improved variation of the loss as a function of the inlet angle of incidence.

Author

Cascade Flow; Compressor Blades; Leading Edges; Turbulence Models; Angles (Geometry)

19960024808 Technical Univ. of Lodz, Inst. of Turbomachinery., Lodz, Poland

BOUNDARY LAYER AND LOSS STUDIES ON HIGHLY LOADED TURBINE CASCADE

Smolny, A., Technical Univ. of Lodz, Poland; Blaszczak, J., Technical Univ. of Lodz, Poland; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The test results of a boundary layer developing on the suction side of the highly loaded turbine vane are presented. The tests of the boundary layer development were performed with hot film transducers deposited on a polyimide foil and glued to the profile wall. Special attention was paid to a formation of a separation region. Total pressure losses with regard to the boundary layer condition on the suction side of the profile were determined.

Author

Boundary Layer Flow; Cascade Flow; Aerodynamic Characteristics; Reynolds Number; Turbulent Flow; Vanes; Leading Edges

19960024809 Allison Engine Co., Indianapolis, IN United States

THE EFFECT OF VANE-BLADE SPACING ON TRANSONIC TURBINE STAGE PERFORMANCE

Kelecy, F. J., Allison Engine Co., USA; Griffin, J. W., Allison Engine Co., USA; Delaney, R. A., Allison Engine Co., USA; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804

Contract(s)/Grant(s): NAG3-1645; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

This paper presents the results of a computational study on the effect of axial spacing between the vane and blade rows of a transonic turbine stage. The study was performed on the mid-span section of a high-pressure turbine stage using a quasi-3D, unsteady Navier-Stokes solver that provides a fully interactive vane-blade unsteady flow solution. Three different cases were considered, corresponding to axial spacings of 20%, 40%, and 60% of the vane axial chord. The calculated vane and blade pressure distributions for the 40 percent case were found to compare favorably with experimental measurements acquired in a short-duration shock tunnel. In addition, the analysis shows a marked increase in the amplitude of the unsteady pressure fluctuations on the vane and blade surfaces as the spacing decreases. Time-averaged stage adiabatic efficiency predictions for each case are presented to show the effect of spacing on aerodynamic performance.

Author

Aerodynamic Characteristics; Navier-Stokes Equation; Turbine Blades; Unsteady Flow; Turbulence Models; Supersonic Turbines

19960024810 Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese, Belgium

A REVIEW OF THE RESEARCH ON UNSTEADY TURBINE BLADE WAKE CHARACTERISTICS

Cicatelli, G., Von Karman Inst. for Fluid Dynamics, Belgium; Sieverding, C. H., Von Karman Inst. for Fluid Dynamics, Belgium; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The research on unsteady wake flows behind turbine blades is the orphan of turbomachinery research. The statement that blade wake flows are characterized by the presence of so called von Karman vortex streets, is a common-place, but yet, only very few researchers concluded that this phenomenon deserved their attention. The paper attempts to summarize the available bits and pieces and provides the reader with the state of art of our present knowledge in this domain. In many circumstances, the authors have to rely on research results on flows behind cylinder. Schlieren, interferometry and smoke visualizations are used to illustrate the existence of vortex street in a wide variety of cascade and flow conditions. The difference in the Strouhal number describing the vortex shedding frequency behind turbine blades and cylinders is explained and the effect of the vortical motion on the base pressure is discussed. A description of the vortex generation mechanism and the wake structure, developed for flows over cylinders, proves useful in the interpretation of the instantaneous stream lines in time varying turbine blade wakes containing large coherent structures.

Author

Base Pressure; Vortex Streets; Turbine Blades; Cascade Flow; Vortex Shedding; Unsteady Flow

19960024811 Ancona Univ., Dipt. di Energetica., Ancona, Italy

SECONDARY FLOWS IN A TURBINE CASCADE AT OFF-DESIGN CONDITIONS

Bassi, F., Ancona Univ., Italy; Savini, M., Bergamo Univ., Italy; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 10p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

In this work a finite volume full 3-D Navier-Stokes solver equipped with the two equation k-w turbulence model is described. The code is applied to the analysis of the secondary flows occurring

in a low aspect ratio turbine cascade both at design and at highly off-design incidence angle. Numerical results and experimental data concerning loss, flow angle, and turbulent kinetic energy distributions are compared and discussed. Aim of the work is to investigate the capability of the physical models, namely of the turbulence model, to simulate the marked three-dimensional flow features that characterize the secondary flows at off-design conditions
Author
Navier-Stokes Equation; Three Dimensional Flow; Turbine Blades; Turbulence Models; Cascade Flow; Computational Grids

19960024812 Durham Univ., School of Engineering., United Kingdom
TURBULENCE AND TRANSITION IN SECONDARY FLOWS IN A TURBINE CASCADE
Moore, H., Durham Univ., UK; Gregory-Smith, D. G., Durham Univ., UK; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 12p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The accurate prediction of flows in turbomachinery blade rows requires realistic modelling of turbulence and transition, particularly for loss estimation. The complex secondary flow within a large scale cascade of turbine rotor blades has been measured in detail. In particular hot wire measurements have been made close to the end walls in order to characterize the three-dimensional boundary layers. Although at inlet on the end-wall there is a well developed turbulent boundary layer, this is rolled up into a loss core by the secondary velocities and a new highly skewed boundary layer is formed which exhibits significant laminar characteristics. The physical insights gained by this work have implications for the development of turbulence and transition modelling as well as providing test data for the verification of CFD codes.
Author
Three Dimensional Boundary Layer; Turbomachine Blades; Turbulent Boundary Layer; Cascade Flow; Turbulence Models; Navier-Stokes Equation; Hot-Wire Anemometers

19960024813 Marine Technical Univ., Saint Petersburg, Russia
THREE DIMENSIONAL MODELLING AND SECONDARY FLOWS CONTROL IN GAS TURBINES
Tikhomirov, B. A., Marine Technical Univ., Russia; Pogodin, J. M., Marine Technical Univ., Russia; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 12p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Three-dimensional model of vortex flow in a passage is based on Clebsh's Transformation. The associated computer codes consist of the following modules: finite elements mesh automatic generation, finite elements optimum renumeration, calculation of flow, processing of results, analysis of losses. Losses analysis uses typical elements losses models: friction, turn, expansion losses and losses due to equalization throughout the flow. Two last components of losses are calculated by use of integrating throughout the streamlines of the passage element where the results of 3-D flow calculations are known. The model of mass flux averaged flow in turbine rows with end wall inclination, tangential lean or curvature of the blades has been developed. It is made due to the additional boundary condition along geometrical throats line of blade to blade passage. The boundary condition is radial distribution of meridional stream lines inclination which is based on the principle of flow mass flux maximum. Correlations between different flow models has been developed. Research of secondary flows control problem focuses on the effect of end wall fences, wall and blade ledges use for cross flows limitation. Combination of wall ledge and suction from ledge surface, blade through slots and holes used for gas transportation from pressure to suction blade surface in secondary flows area are also experimentally studied in axial turbines.
Author
Axial Flow Turbines; Turbine Blades; Three Dimensional Models; Vortex Sheets; Secondary Flow; Flow Characteristics; Turbulence Models

19960024814 Vrije Univ., Dept. of Fluid Mechanics., Brussels, Belgium
TIP CLEARANCE FLOW AND LOSS IN AXIAL COMPRESSOR CASCADES
Kang, Shun, Vrije Univ., Belgium; Hirsch, Charles, Vrije Univ., Belgium; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 16p; In English; See also 19960024804; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The tip clearance flow and loss production in a low speed linear compressor cascade with a moving endwall is investigated. The analysis is based on numerical computations with a 3D viscous code, at one tip clearance level. Comparisons with experimental data are given for the stationary wall case. The moving wall modifies significantly the secondary flow field near the wall, by generating the skewing of the inlet endwall boundary layer and dragging the tip leakage vortex towards the pressure side. It is found that the leakage flow near the wall is collateral over most of the chord. Close to the tip surface, however, the flow is highly skewed due to the vena contracta. With the moving wall, the leakage mass flow and pressure drop are noticeably increased.
Author
Wall Flow; Flow Distribution; Leakage; Secondary Flow; Cascade Flow; Three Dimensional Boundary Layer; Turbocompressors; Turbine Blades; Tip Vanes

19960024815 National Technical Univ., Lab. of Thermal Turbomachines., Athens, Greece
PREDICTION OF LOSSES DUE TO THE TIP CLEARANCE PRESENCE IN AXIAL FLOW MACHINES
Nikolos, I. K., National Technical Univ., Greece; Douvikas, D. I., National Technical Univ., Greece; Papailiou, K. D., National Technical Univ., Greece; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 16p; In English; See also 19960024804
Contract(s)/Grant(s): AER2-CT92-0039-AC3A; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Theoretical models for the investigation of the phenomena connected with the tip clearance are presented. A model was developed for the description of the flow through the gap, which recognizes the basic flow characteristics inside the gap. The mass flow rate as well as the pressure losses inside the gap are predicted with sufficient accuracy. A new method, based on the moment of momentum equation, is proposed for the calculation of the shed vorticity and the formation of the leakage vortex. A diffusion model for the vorticity distribution is used for the calculation of the pressure deficit field, so that the total pressure loss profile due to the presence of the leakage vortex, is derived. An algorithm is being set up for the implementation of the above models in a secondary flow calculation method. A complete theoretical procedure was developed, which calculates the crcumferentially averaged flow quantities and their radial variation due to the tip clearance effects. The calculation takes place in successive planes, where a Poisson equation is solved, in order to provide the kinematic field. The self induced velocity is used for the positioning of the leakage vortex. The calculated pressure deficit due to the vortex presence is used, through an iterative procedure, in order to modify the pressure difference in the tip region. Calculation results are compared to experimental ones for axial flow machines. The agreement between theory and experiment is good.
Author
Poisson Equation; Flow Characteristics; Axial Flow Turbines; Tip Vanes; Pressure Distribution; Mass Flow Rate; Vorticity

19960024816 Turbine Specialties, Inc., Salina, KS United States
TIP LEAKAGE LOSS DEVELOPMENT IN A LINEAR TURBINE CASCADE
Peters, David W., Turbine Specialties, Inc., USA; Moore, John, Virginia Polytechnic Inst. and State Univ., USA; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Tip leakage losses were studied in a large-scale linear turbine cascade with a tip clearance gap equal to 2.1 percent of blade height. The cascade was located at the exit of a low speed wind tunnel; the blade exit Reynolds number based upon blade axial chord was 4.5x10(exp 5). The flow was measured at a plane 0.96 axial chords downstream from the blade leading edge. Earlier studies performed at the tip gap exit and at a downstream plane 1.4 axial chords from the blade leading edge were utilized with the present study to understand loss development better. The effect of tip leakage and the corresponding loss production mechanisms involved as the flow mixes out were analyzed. The flow properties at the measurement plane were numerically integrated. to estimate the maximum potential loss of the

cascade, the flow was mixed-out through a momentum analysis. The loss at the measurement plane due to tip leakage was found to be equal to the sum of the total pressure loss within the tip gap and the dissipated tip gap secondary kinetic energy. As the flow proceeded downstream, losses were attributed to dissipation of secondary kinetic energy, trailing edge wake mixing, endwall losses, and primary flow mixing.
Author
Cascade Flow; Flow Characteristics; Low Speed Wind Tunnels; Leakage; Tip Vanes; Energy Dissipation; Turbine Blades; Vortices

19960024817 BMW Rolls-Royce AeroEngines G.m.b.H., Dahlewitz, Germany
REDUCTION OF TIP CLEARANCE AND TIP CLEARANCE NOISE IN AXIAL-FLOW MACHINES
Kameier, Frank, BMW Rolls-Royce AeroEngines G.m.b.H., Germany; Neise, Wolfgang, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

An experimental study is described to investigate the negative effects of the tip clearance gap on the aerodynamic and acoustic performance of axial turbomachines. In addition to the increased broadband levels reported in the literature when the tip clearance is enlarged, significant level increases were observed within narrow frequency bands below the blade passing frequency. Measurements of the pressure and velocity fluctuations in the vicinity of the blade tips reveal that the tip clearance noise is associated with a rotating flow instability at the blade tip which in turn is only present under reversed flow conditions in the tip clearance gap. A turbulence generator inserted into tip clearance gap is found to be effective in eliminating the tip clearance noise and in improving the aerodynamic performance.
Author
Acoustic Properties; Aerodynamic Characteristics; Axial Flow; Blade Tips; Turbine Blades; Axial Flow Turbines; Noise Reduction; Reversed Flow

19960024818 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Stroemungsmechanik., Goettingen, Germany
WAKE DEVELOPMENT DOWNSTREAM OF A TRANSONIC TURBINE INLET GUIDE VANE WITH TRAILING EDGE EJECTION
Kapteijn, Cornelis, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 8p; In English; See also 19960024804
Contract(s)/Grant(s): AER2-CT92-0044; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

The temperature at the inlet of modern high pressure turbines requires an effective cooling of the nozzle guide vanes. This project investigates an annular cascade of internally cooled nozzle guide vanes with bleeding through a slot at the pressure side near the trailing edge. Purpose of the actual work is the determination of the downstream flow field undisturbed by the presence of the rotor with emphasis on the mixing process between main flow and coolant flow. During the second part of this project the investigation of a complete stage will take place, where the present results will enable the elucidation of the flow field deviations due to the rotor presence.
Author
Annular Flow; Cascade Flow; Cooling; Guide Vanes; Supersonic Turbines; Wakes; Multiphase Flow; Inlet Nozzles

19960024819 Cincinnati Univ., Dept. of Aerospace Engineering and Engineering Mechanics., OH United States
FLOW PREDICTIONS IN TRANSONIC TURBINES USING NONPERIODIC GRIDS
Hamed, A., Cincinnati Univ., USA; Yeuan, J. J., Cincinnati Univ., USA; Tabakoff, W., Cincinnati Univ., USA; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 10p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

Numerical results are presented for viscous flow through transonic turbine blades using different turbulence models and H-type grids. The numerical schemes for the solution of the compressible Navier Stokes equations are developed with an option of conservative zonal approach for interpolation across non-periodic boundaries to minimize numerical errors. This makes it possible to use nonperiodic type grids which are more orthogonal and less skewed for improved accuracy in the prediction of turbine blade performance. The results obtained using traditional and nonperiodic H-type grids are compared with the experimental results for transonic turbine cascades and turbine stator vanes.
Author
Navier-Stokes Equation; Turbine Blades; Supersonic Turbines; Turbulence Models; Inlet Nozzles; Three Dimensional Flow; Performance Prediction

19960024820 Wright Lab., Wright-Patterson AFB, OH United States
DEVELOPMENT OF AN OFF-DESIGN LOSS MODEL FOR TRANSONIC COMPRESSOR DESIGN
Bloch, Gregory S., Wright Lab., USA; Copenhaver, William W., Wright Lab., USA; OBrien, Walter F., Virginia Polytechnic Inst. and State Univ., USA; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

A numerical investigation has been conducted to determine the changes in shock geometry that will occur with throttle setting for a modern transonic fan. The passage shock was found to be approximately normal near stall, with increasing obliqueness at higher mass flows. At peak efficiency, the shock system consists of an oblique passage shock followed by a normal shock, with the 2 shocks coalescing near the suction surface. As the back pressure is reduced further, the rotor becomes completely choked and the second shock moves downstream, becoming a separate, full-passage shock. The Mach number upstream of the second shock increases steadily as the shock moves downstream with decreasing back pressure. For all values of back pressure, the second passage shock is approximately normal to the predominant flow direction. Because the flow is supersonic downstream of the first passage shock, there are no changes in the first passage shock along this portion of the characteristic. A simple, but fundamentally based model has been developed which captures the qualitative trends of shock performance over the entire range of design-speed mass flows for a transonic fan. Model predictions are compared with measured data at multiple spanwise locations. The results of the comparison suggest that shock losses contribute a significant share of the total loss, but other mechanisms must also be considered.
Author
Transonic Compressors; Oblique Shock Waves; Mathematical Models; Mass Flow; Turbine Blades; Blade Tips

19960024821 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Antriebstechnik., Cologne, Germany
SHOCK-WAVE TURBULENT BOUNDARY LAYER INTERACTION IN A HIGHLY LOADED TRANSONIC FAN BLADE CASCADE
Schreiber, Heinz-Adolf, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Results of experimental investigations on strong shock-wave turbulent boundary layer interactions in a transonic compressor cascade are presented. The tests have been conducted in a linear cascade facility at inlet Mach numbers, ranging from 1.37 to 1.59, for freestream Reynolds numbers of about 2.7x10(exp 6). The cascade tested is typical for a fan blade tip section with little flow turning, providing a static pressure ratio of more than 2.0. Main interest is concentrated on the blade suction surface, where the oblique extension of the bow shock of the neighboring blade forms a Mach reflection in combination with a boundary layer separation. Structure and loss mechanism of the shock system within the blade passage is discussed. Detailed measurements of the boundary layer within the interaction region and the rear part of the blade were performed. The results show that shock induced boundary layer separation on the tested blade can be controlled for inlet Mach numbers up to 1.42 . At preshock Mach numbers of 1.32 to 1.44, there are only local boundary layer separations with reattachments. Complete boundary layer separation cannot be avoided beyond inlet Mach numbers of 1.45. However, the magnitude of the separation and thus the total pressure losses can be controlled by increasing the axial stream sheet contraction of the blade channel.
Author
Boundary Layer Separation; Shock Waves; Turbulent Boundary Layer; Fan Blades; Cascade Flow; Turbocompressors; Transonic Flow

19960024822 Roketsan A.S. Ankara, Turkey
LOSS PREDICTION ON AXIAL FLOW CASCADES USING A NAVIER-STOKES SOLVER
Tinaztepe, H. Tugrul, Roketsan A.S. Ankara, Turkey; Akmandor, I. Sinan, Middle East Technical Univ., Turkey; Ucer, Ahmet S., Middle East Technical Univ., Turkey; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

In this paper, results of a 3D Navier-Stokes flow solver which uses a cell vertex finite volume method are given. The code uses Lax-Wendroff time integration method and Baldwin-Lomax turbulence model. Validation of the code are presented briefly in terms of modeling accuracy due to viscous effects. An attempt is made to predict shock boundary layer interaction on an airfoil. The paper also gives loss distributions. Effects like separation and secondary flow due to a high turning turbine cascade are discussed. Physical aspects of secondary flow and loss generation mechanisms are investigated in the predicted flow field.
Author
Axial Flow; Cascade Flow; Navier-Stokes Equation; Turbulence Models; Flow Distribution; Three Dimensional Flow; Axial Flow Turbines; Shock Wave Profiles

19960024823 British Columbia Univ., Dept. of Mechanical Engineering., Vancouver, British Columbia Canada
ROTOR-STATOR INTERACTION EFFECTS ON TURBULENT BOUNDARY LAYERS
Evans, R. L., British Columbia Univ., Canada; Holland, R. M., British Columbia Univ., Canada; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 8p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

Compressor and turbine blade boundary layers in axial-flow turbomachines are subject to periodically disturbed flow. This study modelled these conditions in a wind tunnel with circular cylinders traversing in front of a flat plate. Turbulent boundary layer velocity profiles on the flat plate were measured with a hot-wire anemometer. The ensemble-averaged turbulence intensity in the boundary layer was found to be significantly increased by the unsteady free stream flow, resulting in increases in the characteristic boundary layer thicknesses and the skin friction coefficient. The vortex structure within the unsteady cylinder wakes was found to explain the behavior of the velocity and phase angle profiles in the boundary layer.
Author
Rotor Blades (Turbomachinery); Stator Blades; Turbulent Boundary Layer; Turbulence Models; Compressor Blades; Hot-Wire Anemometers; Boundary Layer Separation

19960024824 Paris VI Univ., Orsay, France
EXPERIMENTAL AND NUMERICAL INVESTIGATION OF UNSTEADY FLOW PROPERTIES IN A STATOR OF MULTISTAGE AXIAL FLOW COMPRESSOR
Miton, Hubert, Paris VI Univ., France; Belhabib, Mustapha, Paris VI Univ., France; Kus, Umit, Paris VI Univ., France; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 18p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

This analysis has been performed from tests realized in a four stage low speed axial flow compressor (4000 rpm). First, two unsteady velocities components has been measured, using hot wire anemometry, directly upstream and downstream of the first stage stator in the (r,O) plane. Simultaneously, unsteady flow characteristics has been collected at four blade surfaces. Experimental techniques consisted first in pressure transducers fitted in the inner part of the profiles, then, in series of hot films (29), bounded, at two different radial positions, to the blade surfaces. These films were uniformly distributed orthogonaly to the axial direction, from leading to trailing edges. Data have been processed in view to identify the multiple origins of excitation from the other parts of the machine and to describe the behavior of the boundary layer along the blade surfaces. Comparison of the experimental results with the ones given by a two-dimensional blade to blade computation method, taking into account the development of the boundary layer, has been performed.
Author
Unsteady Flow; Hot-Wire Anemometers; Turbocompressors; Turbine Blades; Boundary Layer Equations

19960024825 Universitaet der Bundeswehr Muenchen, Inst. fuer Strahlantriebe, Neubiberg, Germany
THE EFFECT OF INCOMING WAKES ON BOUNDARY LAYER TRANSITION OF A HIGHLY LOADED TURBINE CASCADE
Engber, M., Universitaet der Bundeswehr Muenchen, Germany; Fottner, L., Universitaet der Bundeswehr Muenchen, Germany; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 12p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Extensive pressure and thin-film measurements have been performed on a linear turbine cascade with variations of inlet angle, inlet Reynolds number, and inlet turbulence intensity at homogeneous and inhomogeneous inflow conditions. Especially the occurrence of laminar separation bubbles was investigated. With both measuring techniques their existence could be verified and the characteristic points of a bubble could be located. Incoming wakes similar to those in real turbomachines were simulated by a cascade of cylindrical bars which was positioned in front of the turbine cascade. Diameter and distance of the bars to the blades were chosen to produce nonuniformities in the cascade inlet plane similar to those in real engines. The wake impingement point could be varied by moving the cylindrical bars in circumferential direction parallel to the turbine cascade front With this set-up the so called rotor-rotor or stator-stator interaction of a multistage turbine can be simulated. Measurements of direction, quantity and actuation of the velocity inside the boundary layer have been conducted with a Laser-2-Focus measuring technique. The analysis of the experiments results in a better understanding of the transitional phenomena on blade profiles and allows to improve empirical correlations for the calculation of transition in boundary layer.
Author
Boundary Layer Transition; Bubbles; Cylindrical Bodies; Cascade Flow; Turbomachinery; Wakes; Rotor Blades (Turbomachinery); Stator Blades; Turbulence Models

19960024826 Oxford Univ., Dept. of Engineering Science., Oxford, United Kingdom
UNSTEADY PRESSURE AND HEAT TRANSFER MEASUREMENTS ON A ROTATING BLADE SURFACE IN A TRANSIENT FLOW FACILITY
Moss, R. W., Oxford Univ., UK; Sheldrake, C. D., Oxford Univ., UK; Ainsworth, R. W., Oxford Univ., UK; Smith, A. D., Rolls-Royce Ltd., UK; Dancer, S. N., Rolls-Royce Ltd., UK; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 12p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The Oxford rotating turbine facility has been used to obtain measurements of blade surface heat flux, static pressure and relative inlet velocity. The measurements provide time resolved data which is compared with predictions from a two-dimensional unsteady flow calculation.
Author
Turbulent Heat Transfer; Unsteady Flow; Turbine Blades; Rotor Blades (Turbomachinery); Two Dimensional Flow

19960024827 Cambridge Univ., Cambridge, United Kingdom
WAKE PASSING IN LP TURBINE BLADES
Banieghbal, M. R., Cambridge Univ., UK; Curtis, E. M., Cambridge Univ., UK; Denton, J. D., Cambridge Univ., UK; Hodson, H. P., Cambridge Univ., UK; Huntsman, I., Cambridge Univ., UK; Schulte, V., Cambridge Univ., UK; Harvey, N. W., Rolls-Royce Ltd., UK; Steele, A. B., Rolls-Royce Ltd., UK; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 12p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

A study of the effect of wake passing on the boundary layer of a modern low pressure (LP) turbine is presented. Typically, such blading operates at low Reynolds numbers. As a consequence, significant regions of laminar flow might be expected to occur together with transition via laminar separation bubbles. This paper examines the behavior of the surface boundary layers in environments typical of modern low pressure turbines. Results were obtained from arrays of surface mounted hot-film anemometers in the 3rd stage stator of a LP turbine. The results are considered in relation to more detailed experiments carried out in a steady flow high-speed linear turbine cascade and also with reference to tests carried out in a low-speed linear turbine cascade fitted with a mechanism that simulates the presence of upstream rotor wakes. It is found that, although there are some differ-

ences in details, the results from the turbine are consistent with the cascade observations. The suction surface boundary layer is little affected by wakes over the forward half of the surface and remains laminar. Downstream of peak suction, laminar separation occurs and the main effect of the wakes appears to be to promote transition in the separated region. Nevertheless, even in the presence of wakes, laminar flow persists for part of the time right up to the trailing edge. Over most of the Reynolds number range, the wake effects add to the loss, but at the lowest Reynolds numbers ((Re less than 1x1O)(exp 5)), the wakes reduce the profile loss as compared to the steady flow situation, probably by assisting reattachment. The large element of laminar flow, even though there is considerable diffusion over the rear part of the suction surface, leads to low losses for this profile.
Author
Turbine Blades; Wakes; Laminar Flow; Cascade Flow; Boundary Layer Transition; Wind Tunnel Tests; Rotor Blades (Turbomachinery); Stators

19960024828 Defence Research Agency, Pyestock, United Kingdom
UNSTEADY MEASUREMENTS IN AN AXIAL FLOW TURBINE
Hilditch, M. A., Defence Research Agency, UK; Smith, G. C., Defence Research Agency, UK; Anderson, S. J., Defence Research Agency, UK; Chana, K. S., Defence Research Agency, UK; Jones, T. V., Oxford Univ., UK; Ainsworth, R. W., Oxford Univ., UK; Oldfield, M. L. G., Oxford Univ., UK; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 10p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

Fast response instrumentation has been used to measure the unsteady flow field in an axial flow turbine mounted in a transient test facility. The results show significant fluctuations in static pressure and heat transfer rate at mid-span on the rotor blade. The rotor is shown to have a limited influence on the heat transfer to the nozzle guide vane at midspan.
Author
Axial Flow Turbines; Flow Distribution; Guide Vanes; Unsteady Flow; Rotor Blades (Turbomachinery); Pressure Measurement

19960024829 Royal Military Coll. of Canada, Kingston, Ontario Canada
ROTATING STALL IN TURBOJET ENGINE COMPRESSORS
Borys, W. J., Royal Military Coll. of Canada, Canada; Moffatt, W. C., Royal Military Coll. of Canada, Canada; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 12p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Losses in an axial compressor are generally ascribed to the effects of shock waves or viscosity, the latter including boundary layer growth, separation, wakes, and secondary flows. Rotating stall is a viscosity-related phenomenon whose effects are well understood, but whose origins and prediction have defied definitive analysis. Experimental approaches to understanding such stalls have for very practical reasons been performed primarily on laboratory scale compressors; there is little information in the open literature on installed units. This paper presents the results of several studies of rotating stall characteristics for a compressor in a turbojet engine, including determination of the conditions in which stall is found, the characteristics of the stall pattern, some details of the flows within the cells, and the effects of inlet distortions on the nature of the stall. Flow characteristics were found using hot film anemometer probes for all the tests. Also included is a brief description of an experimental evaluation of the effects of temperature changes within the compressor on the accuracy of constant temperature hot film anemometer measurements.
Author
Aerodynamic Stalling; Boundary Layer Separation; Temperature Measurement; Turbojet Engines; Viscosity; Rotating Stalls; Wakes; Turbocompressors

19960024830 Motoren- und Turbinen-Union Muenchen G.m.b.H., Munich, Germany
STALL INCEPTION AND SURGE IN HIGH-SPEED AXIAL FLOW COMPRESSORS
Breuer, T., Motoren- und Turbinen-Union Muenchen G.m.b.H., Germany; Servaty, S., Motoren- und Turbinen-Union Muenchen G.m.b.H., Germany; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 18p; In English; See also 19960024804
Contract(s)/Grant(s): AER2-CT92-0039; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The results of experimental and numerical studies to examine the inception process of rotating stall and surge are presented. Unsteady pressure measurements have been carried out in a 3-stage high speed compressor to reveal characteristic features of instability onset. Tests have been conducted with clean intake as well as a circumferential inlet distortion. Analysis of the data shows that instability starts from small amplitude disturbances rotating in rotor direction, finally leading to either rotating stall or surge. A numerical model is used to calculate the instability onset in a compression system comprising of ducts, blade rows and volumes. The model is based on the unsteady two-dimensional Euler-equations in conservation law form. The influence of blade rows is simulated by source terms to account for pressure loss and energy input. Some results of computations are compared to the experimental results.
Author
Rotating Stalls; Turbocompressors; Mathematical Models; Surges; Rotor Blades (Turbomachinery); Unsteady Flow; Active Control

19960024832 NASA Lewis Research Center, Cleveland, OH United States
COMPARISONS BETWEEN UNSTEADY AERODYNAMIC EVENTS IN A GAS TURBINE GENERATOR AND AN IDENTICAL COMPRESSOR RIG
Owen, A. Karl, Army Research Lab., USA; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 18p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Extensive testing done on a T55-L-712 turboshaft engine compressor in a compressor test rig is being followed by engine tests in progress as part of the Army Non-Recoverable Stall Program. Goals include a greater understanding of the gas turbine engine start cycle and compressor/engine operation in the regions 'beyond' the normal compressor stall line (rotating stall/surge). Rig steady state instrumentation consisted of 497 steady state pressure sensors and 153 temperature sensors. Engine instrumentation was placed in similar radial/axial locations and consists of 122 steady state pressure sensors and 65 temperature sensors. High response rig instrumentation consisted of 34 wall static pressure transducers. Rig and engine high response pressure transducers were located in the same axial/radial/circumferential locations in front of the first three stages. Additional engine high response instrumentation was placed in mach probes in front of the engine and on the compressor hub. This instrumentation allows for the generation of detailed stage characteristics, overall compressor mapping, and detailed analysis of dynamic compressor events.
Author
Turboshafts; Unsteady Aerodynamics; Rotating Stalls; Surges; Gas Turbine Engines; Pressure Sensors

19960024833 Garrett Turbine Engine Co., Phoenix, AZ United States
SURGE AND STALL CHARACTERISTICS OF AXIAL-CENTRIFUGAL COMPRESSORS: THE ENHANCEMENT TO ENGINE STABILITY
Cousins, W. T., Garrett Turbine Engine Co., USA; Jones, M. G., Garrett Turbine Engine Co., USA; Belling, T. L., Garrett Turbine Engine Co., USA; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The characteristics of axial-centrifugal compressors in gas turbine engines that provide an enhanced tolerance to engine stall and surge are presented. The incipient, post-stall, and recovery behavior of axial-centrifugal compressors is described. Unique high-response measurements showing the pressure/flow characteristics of post-stall behavior are presented and the measurement techniques are discussed. Comparison of compressor stall and surge, with and without a centrifugal stage, shows the benefit of using axial-centrifugal technology in gas turbine engines. A discussion is presented on the importance and the technique of detecting the compressor stage that has the potential to initiate instability under highly-loaded conditions. Data are presented from both compressor rigs and engines. An explanation of how to distinguish the stalling stage prior to surge in a compressor is included. The effect of interstage bleed on the axial-

centrifugal stage match in the engine environment is shown, along with the changes in surge initiation due to speed mismatch that can occur at high altitude conditions.
Author
Aerodynamic Stalling; Centrifugal Compressors; Gas Turbine Engines; Turbocompressors; Flow Characteristics; Surges; Turbine Blades

19960024834 Technische Univ., Inst. fuer Stroemungsmaschinen., Hanover, Germany
INITIATION AND PROPAGATION OF FLOW INSTABILITIES IN MULTI-STAGE AXIAL COMPRESSORS
Riess, W., Technische Univ., Germany; Walbaum, M., Technische Univ., Germany; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 12p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Axial Compressors for all the different applications are required to have an operating range as large as possible with high efficiency. The increase of aerodynamic stage loading renders, however, a distinct narrowing of the characteristic field. Broader and deeper knowledge of the mechanisms governing the initiation and propagation of flow instabilities near the stability limit of compressors would permit an optimized compressor design with full exploitation of the aerodynamic limits, which could result in a considerably increased operating range. In addition new methods for instability detection could be foumd, which would allow operation near the surge limit with the aid of on-line surge control. The mechanisms of initiation and propagation of flow instabilities are investigated in a six-stage axial compressor with guide vane adjustment. by systematic modification of the aerodynamic loading of the different stages the propagation of disturbances and the interactions between disturbed and not disturbed flow in a multi-stage environment can be studied. Radial traverses with a six-hole probe and peripherly distributed pressure sensors render information on instationary flow phenomena as local backflows or transition from two-cell stall to single-cell stall. The results give the possibility to check different models for flow instability and develop methods for instability detection.
Author
Turbocompressors; Guide Vanes; Pressure Sensors; Flow Stability; Surges; Rotating Stalls; Propagation Modes

19960024837 Sverdrup Technology, Inc., Arnold AFS, TN United States
EULER MODELING TECHNIQUES FOR THE INVESTIGATION OF UNSTEADY DYNAMIC COMPRESSION SYSTEM BEHAVIOR
Davis, M. W., Jr., Sverdrup Technology, Inc., USA; Hale, A. A., Sverdrup Technology, Inc., USA; Shahrokhi, K. A., Sverdrup Technology, Inc., USA; Garrard, G. D., Sverdrup Technology, Inc., USA; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 10p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

The development of advanced turbine engine simulations is a necessity for the analysis of turbine engine dynamic events such as compressor surge, rotating stall, and inlet distortion. Simulations can fill information gaps and extend the range of test results to areas not tested. In addition, once a simulation has been validated, the model can become a numerical experiment and the analysis engineer can conduct 'what-if' studies to determine possible solutions to performance or operability problems. Turbine engine simulations can range from the one-dimensional cycle codes to the most complex computational fluid dynamics formulations. For dynamic events, the full Navier-Stokes solution is not feasible. However, computerized fluid dynamics (CFD) solutions using the Euler equations have achieved a good measure of success. This paper discusses both one-dimensional and three-dimensional Euler solution techniques that have been developed at the Arnold Engineering Development Center (AEDC) and applied to dynamic simulations for gas turbine engine compressors and the extension of the one-dimensional technique to the full turbine engine.
Author
Computational Fluid Dynamics; Gas Turbine Engines; Euler Equations of Motion; Rotating Stalls; Surges; Three Dimensional Flow

19960024839 Centre National de la Recherche Scientifique, Orsay, France
ON THE COMPUTATION OF UNSTEADY TURBOMACHINERY FLOWS, PART 2, ROTOR/STATOR INTERACTION USING EULER EQUATIONS
Gerolymos, G. A., Centre National de la Recherche Scientifique, France; Vinteler, D., Centre National de la Recherche Scientifique, France; Haugeard, R., Centre National de la Recherche Scientifique, France; Tsanga, G., Centre National de la Recherche Scientifique, France; Vallet, I., Centre National de la Recherche Scientifique, France; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 16p; In English; See also 19960024804; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The purpose of this paper is to present a methodology for the prediction of unsteady flow resulting from rotor/stator interaction in multistage axial compressors. The methodology consists of a time-averaged multistage flow computation, which is used to initialize unsteady flow computations, dealing with a single stage and using chorochronic periodicity. Currently, time-marching Euler solvers are used for the time-averaged multistage computation, and for rotor/stator interaction computations, which can be coupled to an assumed-modes mechanical model. The development of a 3-D time-linearized Euler solver is also described. Typical results are presented and the methodology is validated through comparison with available data, both theoretical (analytical) and experimental. The updating of the methodology to Navier Stokes solvers is discussed in detail, and some preliminary results are presented. The urgent need for reliable and detailed unsteady aeromechanical experimental data is stressed as a major pacing-item in methodology development.
Author
Computational Fluid Dynamics; Turbomachinery; Unsteady Flow; Time Marching; Periodic Variations; Rotor Blades (Turbomachinery); Stators; Three Dimensional Flow

19960024840 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Dept. of Compressor Aerodynamics., Moissy-Cramayel, France
NUMERICAL SIMULATIONS OF STATOR-ROTOR INTERACTIONS OF COMPRESSOR BLADE ROWS
Liamis, N., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Bacha, J. L., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Burgaud, F., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 12p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

A numerical analysis of the unsteady flow field in a single stage axial transonic compressor is presented, with the aim of exhibiting typical unsteady phenomena resulting from the rotor-stator interactions. Firstly, a 3D Euler solver is used to investigate the unsteady effects generated by the inlet guide vane-rotor-stator relative motion, for several operating points of the compressor. Various features of the unsteady compressor flow field are examined: the non-uniformity of the flow in the stator, the influence of the operating point, and the location of the unsteadiness on each blade surface. A quasi-3D Navier-Stokes analysis of the inlet guide vane-rotor interaction is then conducted and shows the large influence of moving oblique shocks on the inlet guide vane instantaneous outlet angles and velocities.
Author
Stators; Turbocompressors; Compressor Blades; Rotor Stator Interactions; Guide Vanes; Flow Distribution; Rotor Blades (Turbomachinery); Unsteady Flow

19960024841 Cambridge Univ., Cambridge, United Kingdom
UNSTEADY FLOW AND LOSS PRODUCTION IN CENTRIFUGAL AND AXIAL COMPRESSOR STAGES
Dawes, W. N., Cambridge Univ., UK; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 38p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The aim of this paper is to help advance our understanding of the complex, three-dimensional, unsteady flows associated with the inter-blade row interactions in compressor stages. to achieve this, time-resolved, 3D, unsteady Navier-Stokes simulations were performed for two contrasting stages: a splittered centrifugal compressor with a

vaned diffuser; and a transonic axial flow compressor. The interest in the first stage is the interaction with the diffuser blades of the jet-wake flow emerging from the wheel. In the second stage the focus is on the interaction of the rotor over-tip leakage vortex with the downstream stator row. The predicted flowfields were interrogated from the perspective of loss production to try and determine any contribution of the unsteady flow to the loss levels and, hence, to the time-average performances of the stages. Specifically, the time-averaged entropy production rate was compared with the entropy production rate of the time-averaged flow. Thereby, any contribution to loss production directly associated with unsteadiness could be identified.
Author
Centrifugal Compressors; Turbocompressors; Three Dimensional Flow; Unsteady Flow; Vortices; Leakage; Rotor Stator Interactions; Wakes

19960024842 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Antriebstechnik., Cologne, Germany
NUMERICAL INVESTIGATION OF INVISCID AND VISCOUS INTERACTION IN A TRANSONIC COMPRESSOR
Eulitz, Frank, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Engel, Karl, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Pokorny, Stefan, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The paper presents inviscid and viscous results of unsteady flow calculations for a stator-rotor configuration of a transonic compressor. The calculations were run on a massively parallel hardware architecture. A second-order upwind total-variation diminishing scheme is employed in combination with a second order Runge-Kutta time integration method. The in- and outflow boundaries are treated with non-reflecting boundary techniques. The validity of the numerical method for time accurate calculations is thoroughly assessed by comparison to linear theory and experiments. In the analysis part of the paper, emphasis is on the stage interaction physics. A Fourier analysis of the stator blade pressure reveals fluctuations with a maximum amplitude close to 10 percent of the time-average. In the viscous case, the interaction of the observed propagating pressure waves with the boundary layer induces unsteady flow separation. Turbulence is accounted for by using either the Baldwin-Lomax or Spalart-Allmaras model. The influence of the turbulence model on the viscous solution is taken into account.
Author
Transonic Compressors; Turbulence Models; Boundary Layer Separation; Inviscid Flow; Pressure Oscillations; Rotor Stator Interactions; Parallel Processing (Computers)

19960024843 Technische Univ., Inst. fuer Strahlantriebe und Turboardeitsmaschinen., Aachen, Germany
STATOR-ROTOR-STATOR INTERACTION IN AN AXIAL FLOW TURBINE AND ITS INFLUENCE ON LOSS MECHANISMS
Walraevens, R. E., Technische Univ., Germany; Gallus, H. E., Technische Univ., Germany; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Detailed measurements have been carried out to investigate in particular the development of the rotor wakes and vortices, entering, passing and leaving the second stator. Pneumatic measurements in the axial gaps behind all blade rows provided information about the steady flow behavior. Hot-wire measurements with double- and triple wire probes have been performed behind rotor and second stator to acquire the time dependent three-dimensional velocity vector. Surface mounted hot film gages and highly sensitive subminiature pressure transducers were used to get information about the boundary layer behavior of the stator blades. This paper concentrates on the rotor flow and its time dependent influence on the flow behind the second stator. Results will be discussed mainly from figures showing time dependent secondary flow. Typical passage vortices dominate the rotor exit flow in the relative and absolute frame. It will be shown that the vortices leaving the rotor passage influence strongly the second stator exit flow. This leads to highly three-dimensional unsteady effects. Even time averaged quantities show rotor flow phenomena in the exit flow of the second stator.
Author
Rotor Stator Interactions; Secondary Flow; Axial Flow Turbines; Rotor Blades (Turbomachinery); Losses; Boundary Layer Separation; Wakes

19960024844 Defence Research Agency, Propulsion Technology Dept., Pyestock, United Kingdom
ROTOR-STATOR INTERACTION IN HIGH-SPEED AXIAL COMPRESSOR
Cherrett, M. A., Defence Research Agency, UK; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Detailed unsteady aerodynamic measurements have been taken in a single-stage transonic fan with a very high stage hub loading. 2D dynamic yawmeters were traversed at rotor and stator exit, while dynamic pressure sensors and heated thin-film gauges were fitted to the stator at mid-span. This paper concentrates largely on analysis and interpretation of the on stator measurements supplemented by consideration of some of the stator exit measurements and an inviscid-viscous prediction of the flow about the stator. These data show that at mid-span the rotor wakes augmented an incipient stator suction surface separation, causing a transient (larger) separation and reattachment. This gave rise to an acoustic disturbance which propagated upstream, where it interacted with subsequent rotor wakes. At these points of interaction, large amplitude static pressure fluctuations were induced. Wake convection was seen in both pressure and thin-film gauge data taken on the suction surface, although there was a complex relationship between both data sources. However, rotor wake convection was absent from the pressure surface pressure-field data despite evidence of 'negative-jet' effects convecting the rotor wake fluid toward the pressure surface of the stator.
Author
Rotor Stator Interactions; Pressure Sensors; Unsteady Aerodynamics; Axial Flow; Turbocompressors

19960024845 Central Inst. of Aviation Motors, Moscow, Russia
EXPERIMENTAL INVESTIGATION OF FLOW STRUCTURE AND LOSSES IN A HIGH LOAD TRANSONIC TURBINE STAGE
Granovskii, A. V., Central Inst. of Aviation Motors, Russia; Karelin, A. M., Central Inst. of Aviation Motors, Russia; Popov, K. M., Central Inst. of Aviation Motors, Russia; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 14p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

The investigation of a loss mechanism and flow pattern in a high load transonic single stage high pressure turbine is presented. The part of real vane row (vane sector) and midspan plane blade cascade were tested to obtain the flow structure and the level of losses for a wide range of outlet isentropic Mach -number from 0.7 to 1.4. During these tests flow visualization, total and static pressure and wake measurements were made. An inviscid and viscous computer codes and Bezier polynomials were used to the blade design by interactive technique. These experimental and calculated data were used for the stage design and analysis. The experimental stage was tested with changing of a tip clearance. The blade tip clearance values were measured by optical system. Comparison between measured and calculated performance of the experimental stage was carried out.
Author
Blade Tips; Flow Visualization; Supersonic Turbines; Guide Vanes; Wakes; Loads (Forces)

19960024846 Virginia Polytechnic Inst. and State Univ., Dept. of Mechanical Engineering., Blacksburg, VA United States
CASCADE SIMULATION OF MULTIPLE SHOCK PASSING FROM UPSTREAM BLADE ROWS
Doughty, R. I., Virginia Polytechnic Inst. and State Univ., USA; Schetz, J. A., Virginia Polytechnic Inst. and State Univ., USA; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 16p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A03, Hardcopy; A06, Microfiche

Shock waves shed from the trailing edges of current high pressure turbine blades for aircraft engines are believed to cause a decrease in the efficiency of downstream stages. A simulation of the

effects of unsteady shock waves is developed here, using a shock tube with multiple outlets to produce three shock waves. Time delays between the shocks are introduced using a duct length differential. The three shocks are passed upstream of a cascade of turbine blades traveling tangentially along the cascade leading edge. Shock periods of 0.055 msec and 0.200 msec are used. Shadowgraphs of the shock diffraction in the blade passages are presented. The shocks are also found to have a significant effect on unsteady blade static pressures and forces.
Author
Cascade Flow; Aircraft Engines; Turbomachine Blades; Shock Waves; Leading Edges; Trailing Edges

19960054418 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
ADVANCED AERO-ENGINE CONCEPTS AND CONTROLS *LES CONCEPTS AVANCES ET LES COMMANDES DES NOUVEAUX MOTEURS D'AVION*
Jun. 1996; 428p; In English; In French, 25-29 Sep. 1995, Seattle, WA, USA; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19960054419 through 19960054454 Report No.(s): AGARD-CP-572; ISBN 92-836-0025-8; Copyright Waived; Avail: CASI; A19, Hardcopy; A04, Microfiche

The Propulsion and Energetics Panel Symposium on Advanced Aero-Engine Concepts and Controls was held from 25-29 September 1995 in Seattle, Washington, USA. It dealt with propulsion, including thrust vectoring, for future combat aircraft, vertical landing aircraft and transport aircraft. Better fuel efficiency, longer range and higher operational flexibility will be gained from aero engines with advanced cycles which require improvements in fluid dynamics, materials and cooling. Five Sessions (37 papers including the keynote): Engine research and demonstration, requirements and programmes (3); Aircraft engine integration (5); Propulsion system and component technology (IO); Engine control systems (I 3); Integrated flight and propulsion control (5). Dual use application of results is intended.
Author
Aircraft Engines; Conferences; Engine Control; Thrust Vector Control; Propulsion System Configurations; Propulsion System Performance; Engine Airframe Integration; Inlet Airframe Configurations; Engine Design; Control Systems Design

19960054419 Wright Lab., Turbine Engine Div., Wright-Patterson AFB, OH United States
THE PURPOSE AND STATUS OF IHPTET: 1995
Hill, Richard J., Wright Lab., USA; Advanced Aero-Engine Concepts and Controls; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper discusses the purposes (background, goals, and applications) and the status of the Integrated High Performance Turbine Engine Technology (IHPTET) program through July 1995. IHPTET is a coordinated, three phase, government and industry sponsored propulsion program. It includes virtually all government and industry sponsored research and development (R&D) activities devoted to advancing technology for military turbine engines.
Derived from text
Aircraft Engines; Engine Design; Gas Turbine Engines; Government/Industry Relations

19960054420 Ministry of Defence, Directorate of Future Systems (Air), London, United Kingdom
FUTURE TECHNOLOGY REQUIREMENTS FOR UK COMBAT ENGINES
Paramour, M. D., Ministry of Defence, UK; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper reviews the future requirements of the UK Services for combat engines, and discusses the design considerations and technology that will be required to meet them. Emphasis is placed on the need for improved reliability and maintainability and reduced life-cycle costs, as well as improved performance. Current and proposed technology demonstrator programs, to be undertaken both nationally and in collaboration with other nations, to ensure that the technology will be available, are described.
Author
Cost Reduction; Life Cycle Costs; Engine Design; Technology Utilization; Military Aircraft; STOVL Aircraft

19960054421 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Future Technologies for Military Engines, Moissy-Cramayel, France
ACQUISION AND DEMONSTRATION OF TECHNOLOGIES FOR FUTURE MILITARY ENGINES: THE AMET PROGRM *ACQUISION ET DEMONSTRATION DES TECHNOLOGIES POUR FUTURS MOTEURS MILITAIRES: LE PROGRAMME AMET*
Dufau, Jacques, Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Jun. 1996; 8p; In French; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Requirements for a high performance weapons system that go beyond aeronautical programs already underway, among which are the Eurofighter 2000, the Rafale, and the F-22, are leading to constant study on aspects for improvements to the quality of the carrier aircraft such as: the air frame, armament system, engine system, and integration. In addition to the simple set of rough performance features, it will also be necessary to manage the ownership cost (life-cycle costs) of these new systems. Progress made by engine developers is traditionally measured by means of; the thrust to weight ratio of the propulsion system, the specific consumption (at full speed and at partial modes during supersonic or subsonic cruising) of the turbojet engine, discretion (radar electromagnetic signature and emissions radiating in the infrared range), acquisition and use cost of the equipment. A program to improve the characteristics mentioned above has already begun. It is the advanced military engine technology (AMET) program.
Author
Life Cycle Costs; Military Technology; Turbojet Engines; Engine Design; Radar Signatures; Technology Utilization

19960054422 Defence Research Agency, Pyestock, United Kingdom
THE IMPACT OF ADVANCED ENGINE TECHNOLOGY ON COMBAT AIRCRAFT PERFORMANCE
Hodder, S. D., Defence Research Agency, UK; Simm, S. E., Defence Research Agency, UK; Advanced Aero-Engine Concepts and Controls; Jun. 1996; 20p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper examines how advanced engine technology can affect the design and performance of an air-to-air combat aircraft optimized for typical combat air patrol and intercept missions. The impact of cycle temperatures, component efficiencies, cooling effectiveness and engine thrust-weight ratio are studied independently to assess the relative benefits of each aspect of engine technology. Both fixed and variable cycles are considered, enabling the contributions of advanced technology and of cycle variability to be separated.
Author
Aircraft Performance; Fighter Aircraft; Thrust-Weight Ratio; Engine Design; Technology Utilization; Military Technology

19960054423 Rolls-Royce Ltd., Bristol, United Kingdom
ADVANCED COMBAT ENGINES: TAILORING THE THRUST TO THE CRITICAL FLIGHT REGIMES
Garwood, K. R., Rolls-Royce Ltd., UK; Round, P., Rolls-Royce Ltd., UK; Hodges, G. S., Rolls-Royce Ltd., UK; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Future combat engines will operate at higher turbine temperatures and overall pressure ratios, which will enable high specific thrusts and good low power specific fuel consumption to be realized. The application of these technologies into aircraft needs to address the weapons platform requirements of agility, range, combat persistence. The influence of engine rating schemes and aircraft performance requirements are discussed with indications that higher specific thrust engines will be required for increase force projection.
Author
Aircraft Performance; Thrust-Weight Ratio; Engine Design; Weapon Systems; Military Technology; Technology Utilization

19960054424 Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn, Germany
THE STRATO 2C PROPULSION SYSTEM: A NEW COMPOUND ENGINE AND CONTROL CONCEPT FOR HIGH ALTITUDE FLYING
Toenskoetter, H., Industrieanlagen-Betriebsgesellschaft m.b.H., Germany; Scheithauer, D., Industrieanlagen-Betriebsgesellschaft m.b.H., Germany; Jun. 1996; 14p; In English; See also 19960054418; Copy-

right Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The propulsion system for the STRATO 2C high altitude long endurance (HALE) aircraft is an example of the development of a power plant that is tailored to a special unconventional usage and even takes advantage of the reliability and low cost of available components as well as the advanced technology of turbine engines. The disadvantages of a compromise in the optimization of the propulsion system did not jeopardize the overall design philosophy. The task of designing a low risk, low cost control system was achieved by: a conventional certified engine control system, and a new digital control system for matching the turbocharger stages under steady state and transient operating conditions for cooling flow control and for rotor speed and manifold pressure limitations.

Author

Control Systems Design; Engine Control; Engine Design; Turbine Engines; Financial Management; Digital Techniques; Computer Aided Design; Propulsion System Performance

19960054425 Wright Lab., Aero Propulsion and Power Directorate, Wright-Patterson AFB, OH United States

PROPULSION CONSIDERATIONS FOR AN ADVANCED VERTICAL TAKE-OFF AND LANDING (VTOL) TRANSPORT AIRCRAFT

Norden, Christopher M., Wright Lab., USA; Stricker, Jeffrey M., Wright Lab., USA; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The objective of this paper is to demonstrate the benefits and challenges of advanced propulsion system technologies on a vertical take-off and landing (VTOL) transport aircraft. The study concentrates on two types of propulsion concepts: mechanical and gas driven configurations. Both use turbofans for cruise and lift fans for vertical operations. A conceptual design analysis for the propulsion components is presented. Unique propulsion design characteristics associated with VTOL aircraft are discussed as well. These include sizing, hover, and operational constraints.

Derived from text

Design Analysis; Engine Parts; Aircraft Design; Transport Aircraft; Turbofans; Engine Design; Lift Fans

19960054426 Rolls-Royce Ltd., Bristol, United Kingdom

POWERPLANTS AND LIFT SYSTEMS FOR ASTROVL AIRCRAFT: THE CHALLENGES TO AN ENGINE MAKER

Pearson, David M., Rolls-Royce Ltd., UK; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper discusses the design requirements and major challenges associated with powerplants for short take-off and vertical landing (STOVL) capable aircraft currently being studied under the Joint Advanced Strike Technology (JAST) program. Challenges specific to four different lift system concepts are described, namely: direct lift, shaft driven fan, gas driven fan, and lift plus lift cruise. Generic issues that must be resolved for any of these powerplants, namely: exhaust design, attitude control provision, reliability and affordability, are also discussed. All of the proposed concepts present significant challenges to the engine maker, particularly if the powerplant is to be used in a conventional take-off and landing (CTOL)/STOVL aircraft as proposed for the JAST program.

Author

STOVL Aircraft; Lift Fans; Aircraft Design; Engine Design; Propulsion System Configurations; Cost Effectiveness

19960054427 Wright Lab., Wright-Patterson AFB, OH United States

DEVELOPING AFFORDABLE GAS TURBINE ENGINES

Skira, Charles A., Wright Lab., USA; Jun. 1996; 8p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The costs of advanced high performance gas turbine engines for future military fighter aircraft applications are explored. The impact of increasing engine performance on the cost of the aircraft was examined and it was found to have a favorable impact on the cost of the weapon system. From an engine viewpoint, advanced component performance and improved cost effective manufacturing methods combine to significantly lower the cost of gas turbine engines on a per pound of thrust basis. Engine component costs were compared and analyzed for a modern fielded engine and an advanced technology, high performance engine. Manufacturing costs and the implication to overall engine cost reduction for advanced technology engines were explored.

Author

Component Reliability; Cost Effectiveness; Cost Reduction; Engine Parts; Gas Turbine Engines; Engine Design; Propulsion System Performance; Service Life

19960054428 Sundstrand Turbomach, San Diego, CA United States

ADVANCED SMALL TURBOPROPULSION ENGINES

Rodgers, Colin, Sundstrand Turbomach, USA; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Candidate advanced turbopropulsion engines to fulfill the requirements for the next generation military small aircraft, drones, and missiles are: turbojets, turboprops, turbofans, air turbo-ramjets, pulsejets, and combinations thereof. Prime requirements are to provide significant range increases with high flight Mach numbers and, in some applications, extended endurance above the tropopause, both of which are primarily dependent upon propulsion system specific fuel consumption trends. Other combinations of turbojets, rockets and ramjets are being studied for operation at even higher Mach numbers, but generally involve variable geometry inlets and exhausts difficult to incorporate on small propulsion vehicles. Preliminary design studies of a variety of advanced small turbopropulsion concepts was conducted recently by the author and associates, including: small stoichiometric air-turbo-ramjets, high pressure ration intercooled turboprop, semi-constant volume turbojet, regenerative feedback turbine engine. This paper compiles the results of these studies and highlights the design features necessary to attain advanced levels of performance.

Author

Engine Design; Fuel Consumption; Propulsion System Configurations; Military Aircraft; Tropopause; Flight Altitude; Range (Extremes)

19960054429 Alfa Romeo S.p.A., Propulsion and Aerothermodynamics, Naples, Italy

PRELIMINARY DESIGN AND PERFORMANCE ANALYSIS OF A VARIABLE GEOMETRY RECUPERATIVE TURBOSHAFT

Colantuoni, S., Alfa Romeo S.p.A., Italy; Colella, A., Alfa Romeo S.p.A., Italy; Mainiero, G., Alfa Romeo S.p.A., Italy; Santoriello, G., Alfa Romeo S.p.A., Italy; Cirillo. L., Alfa Romeo S.p.A., Italy; Iossa, C., Alfa Romeo S.p.A., Italy; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes a performance study of a compact turboshaft engine based on two concepts that can contribute to the performance gains of advanced future propulsion systems: the recuperative cycle and the variable geometry. Cycle optimization is done for a medium helicopter application, minimizing the fuel consumption and taking into account moderate levels of peak gas temperature to guarantee adequate life of the most critical engine hot components. The engine architecture (1000 kW class turboshaft with free turbine) is based on a minimum number of turbomachinery components to reduce the weight of the propulsion system and its global cost (initial and operative). The three gas generator components are: (1) a transonic, high performance, 8 to 1 pressure ratio single stage centrifugal compressor; (2) a very compact, reverse flow, annular flame tube, having a 1600 K combustor exit temperature; (3) a high-loaded, cooled axial flow turbine stage. The variable geometry free-power turbine is counter rotating with respect to the gas-generator rotor and the power output is available at the rear-end of the engine. A heat exchanger recuperator, placed behind the power turbine, contributes to a significant reduction of the engine specific fuel consumption. The components of the engine gas-generator section are based on the results of company research projects in the application of the most advanced computational fluid dynamics (CFD) techniques for the aero-thermal design of turbomachinery and combustors.

Author

Axial Flow Turbines; Combustion Chambers; Engine Design; Engine Parts; Fuel Consumption; Gas Temperature; Variable Geometry Structures; Turboshafts; Heat Exchangers

19960054430 General Electric Co., Aircraft Engines, Cincinnati, OH United States
VARIABLE CYCLE ENGINE CONCEPTS
Johnson, J. E., General Electric Co., USA; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes several of the concepts evaluated during the last three decades, starting with the Air Force defined variable pumping compressor (VAPCOM) and concluding with a general discription of the YF120 variable cycle engine (VCE) that flew in the YF-22 and YF-23 advanced tactical fighter (ATF) prototype aircraft. Section 1.3 describes the final evolution of the F120 type VCE and section 1.4 briefly addresses the current status of VCE development. These development activities lead to an affordable engine that combines the attributes of a high turbine turbojet, i.e. high dry specific thrust and low maximum power specific fuel consumption, with those of a turbofan, i.e., low partial power specific fuel consumption with low gas exhaust temperatures.
Derived from text
Turbojet Engines; Turbofan Engines; Variable Cycle Engines; Engine Design; Propulsion System Performance; Cost Effectiveness

19960054431 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Antriebtechnik, Cologne, Germany
STUDIES ON NOX-EMISSIONS OF SST ENGINE CONCEPTS
Deidewig, F., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Doepelheuer, A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Jun. 1996; 14p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

To predict the engine performance at subsonic and supersonic design and off-design flight conditions a thermodynamical calculation procedure has been developed that describes the engine performance with the help of generalized turbine and nozzle characteristics. to demonstrate the advantages of new engine concepts, including variable cycle and/or intercooler, on an aircraft with a payload of about 10,000 kg a realistic flight trajectory has been chosen, which involves every phase along the entire flight path: take-off, climb, supersonic acceleration, cruise, and descent. The results for the chosen flight routes, including fuel flow rates and NO2 emissions, are compared to a zero-bypass engine, the Olympus 593 Mk610, producing comparable thrust.
Author
Flight Paths; Fuel Consumption; Nitrogen Oxides; Turbofan Engines; Engine Design; Thermodynamics; Variable Cycle Engines; Propulsion System Performance; Combustion Efficiency

19960054432 Royal Military Academy, Dept. of Applied Mechanics, Brussels, Belgium
SCRAMJET PERFORMANCE ANALYSIS AS A FUNCTION OF COMBUSTION PROCESS PARAMETERS *ANALYSE DES PERFORMANCES D'UN SUPERSTATOREACTEUR EN FONCTION DES PARAMETRES DE COMBUSTION*
Hendrick, P., Royal Military Academy, Belgium; Jun. 1996; 10p; In French; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

With a single stage to orbit (SSTO) engine using aerobic propulsion, a considerable gain in the useful load fraction can be obtained only if one reaches at least Mach 14-15 in the aerobic mode. In order to reach this performance level, the use of a scramjet engine with hydrogen fuel is mandatory. This study five analytical results of the sensitivity of performance parameters of a scramjet engine called the Hyperjet Mk.3 (projecting part, external ramp with three segments, supersonic diffuser, insulator, combustion chamber, and internal and external ejection nozzles) that uses hydrogen slush as the stored fuel. Furthermore, it uses active cooling of the airframe walls and of the engine to reheat the fuel after injection. This study was conducted at Mach 15 with a dynamic pressure of 60 kPa and constant total angle of incidence equal to 11 degrees. The code used is an aerothermodynamic code 1.5-D with viscous effects in which the air is considered as the mixture (with nine ingredients) of perfect gases that chemically react with one another.
Author
Aerothermodynamics; Combustion Chambers; Slush Hydrogen; Supersonic Combustion Ramjet Engines; Supersonic Diffusers; Fuel Injection; Propulsion System Performance

19960054433 Motoren- und Turbinen-Union G.m.b.H., Munich, Germany
COMBINED-CYCLE ENGINES FOR HYPERSONIC APPLICATIONS
Heitmeir, F. J., Motoren- und Turbinen-Union G.m.b.H., Germany; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper highlights the technological challenges associated with combined-cycle engines for hypersonic flight (Mach 0 to Mach 7). At first, different possible engine concepts are discussed. Selection criteria such as operating requirements and other boundary conditions are used to narrow down the number of concepts. Furthermore, the technological challenges associated with combined-cycle engines are presented with respect to the selected baseline engine.
Derived from text
Engine Design; Hypersonic Flight; Propulsion System Performance; Hybrid Propulsion; Engine Parts; Combustion Chambers; Air Breathing Engines

19960054434 Technische Univ., Lehrstuhl fuer Flugantiebe, Munich, Germany
DESIGN AND OFF-DESIGN SIMULATION OF HIGHLY INTEGRATED HYPERSONIC PROPULSION SYSTEMS
Esch, Th., Technische Univ., Germany; Hollmeier, S., Technische Univ., Germany; Rick, H., Technische Univ., Germany; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The propulsion system for the lower stage of a two-stage-to-orbit transport system (TSTO) is presented with its main components: mixed compression air inlet, combustion chamber, and single expansion ramp nozzle (SERN). Using an implicit finite-volume Navier-Stokes code the flow fields in these components are studied. Comparisons between experimental data and computational fluid dynamics (CFD) calculations are presented for a two-dimensional high speed inlet, a high temperature reacting three-dimensional combustion chamber flow, and a two-dimensional nozzle/afterbody flow field. to determine the forces and moments acting on the propulsion system, comprehensive studies were performed from transonic to hypersonic flight Mach numbers. The results of these studies form the basis for an accurate description of performance and operating behavior of the propulsion system by performance analysis. At hypersonic speeds the effects of the propulsion system on flight-mechanical behavior is substantial, especially in the event of engine failures. Two failure scenarios were considered: flame out and inlet choking. For both cases, the forces acting on the propulsion system are shown.
Author
Navier-Stokes Equation; Propulsion System Performance; Computational Fluid Dynamics; Engine Failure; Finite Volume Method; Flow Distribution; Hypersonic Flow; Transonic Flight

19960054435 Technische Hochschule, Inst. fuer Luftfahrtantriebe, Stuttgart, Germany
PERFORMANCE OPTIMIZATION OF A TURBORAMJET ENGINE FOR HYPERSONIC FLIGHT
Bareis, B., Technische Hochschule, Germany; Braig, W., Technische Hochschule, Germany; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A turbo-ramjet engine is investigated for the acceleration flight mission of the the lower stage of a two stage space transportation system. The method described in this paper allows for the optimization of the engine control parameters in parallel to the engine performance calculations. For a turbo-ramjet engine, the results of the optimization for an ascent flight mission was well as for the transition from turbo to

ram operation are presented. The results show a strong, highly nonlinear sensitivity of thrust and fuel flow to the flight conditions and engine control parameter settings.
Derived from text
Engine Control; Hypersonic Flight; Turboramjet Engines; Fuel Flow; Optimization; Propulsion System Performance; Engine Design

19960054436 Technische Hochschule, Inst. fuer Strahlantriebe und Turboarbeitsmaschinen, Aachen, Germany
APPLICATION OF A SYSTEM FOR THE MONITORING OF AERODYNAMIC LOAD AND STALL IN MULTI-STAGE AXIAL COMPRESSORS
Hoenen, H., Technische Hochschule, Germany; Gallus, H. E., Technische Hochschule, Germany; Advanced Aero-Engine Concepts and Controls; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

As part of a complete health monitoring system, the observation of aerodynamic compressor load and the detection of stall in multi stage axial compressors is explained in detail. First, the definition of monitoring parameters and the choice of a suitable measuring technique is demonstrated. Based on the design of the system structure, the hardware and software solution is shown. Checking modules and a failure detection mode for all components makes up a large part of the software. With the help of suitable input and output interfaces the system can be adjusted for various applications and the monitoring results can be made visible. Furthermore, the experiences with this system as applied to three multi-stage compressors are reported. The behavior of the monitoring parameters shows a good agreement with the different operating conditions of the compressor as well as for design conditions and operation near the stability limit.
Author
Turbocompressors; Aerodynamic Loads; Failure Modes; Systems Health Monitoring; Propulsion System Performance; Aerodynamic Stalling; Gas Turbine Engines

19960054437 Deutsche Aerospace A.G., Military Aircraft, Munich, Germany
APPLICATION OF THRUST VECTORING TO FUTURE AIRCRAFT DESIGN
Ross, Hannes, Deutsche Aerospace A.G., Germany; Huber, Peter, Deutsche Aerospace A.G., Germany; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper reports on studies and flight test results of the X-31 aircraft demonstrating the effective utilization of thrust vectoring within the conventional and expanded (into the post-stall regime) flight envelope. It addresses also new design options provided by thrust vectoring, in particular, the option to reduce the vertical tail surface.
Author
Aircraft Design; Flight Envelopes; Thrust Vector Control; Tail Surfaces; Aerodynamic Stability; Aircraft Control; Thrust-Weight Ratio

19960054438 Pratt and Whitney Aircraft, West Palm Beach, FL United States
THE F-15 ACTIVE AIRCRAFT: THE NEXT STEP
Bursey, Roger, Pratt and Whitney Aircraft, USA; Jun. 1996; 6p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

As the aerospace industry adjusts to post cold-war budgets, emphasis is shifting rapidly to demonstrating technologies of the future with modern-day fighters before committing them to production. Pratt and Whitney, together with NASA Dryden, US Air Force Wright Laboratories, and McDonnell-Douglas have developed such a system based on the F-15. This testbed aircraft has the capability to demonstrate a wide array of aerodynamic and propulsion integration technologies that will apply to future commercial and military aircraft design. This paper presents the ways and means of how Pratt and Whitney designed, manufactured, and flight tested affordable axisymmetric exhaust nozzles incorporating multi-directional thrust vectoring for the Advanced Control Technology for Integrated Vehicles (ACTIVE) program.
Author
Aircraft Design; Thrust Vector Control; F-15 Aircraft; Flight Tests; Exhaust Nozzles; Research Aircraft

19960054439 Sener Ingenieria y Sistemas S.A., Madrid, Spain
OPTIMIZATION OF ACTUATION AND COOLING SYSTEMS FOR ADVANCED CONVERGENT-DIVERGENT NOZZLES OF COMBAT AIRCRAFT
Sanchez-Tarifa, C., Sener Ingenieria y Sistemas S.A., Spain; Rodriguez-Fernandez, M., Sener Ingenieria y Sistemas S.A., Spain; Rebolo, R., Sener Ingenieria y Sistemas S.A., Spain; Corchero, G., Sener Ingenieria y Sistemas S.A., Spain; Rodriguez-Martin, M., Industria de Turbo Propulsores S.A., Spain; UlizarAlvarez, I., Industria de Turbo Propulsores S.A., Spain; Jun. 1996; 8p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The system or components of a convergent-divergent (CON-DI) nozzle that offer better perspectives for improvement and optimization are the actuation and cooling systems. Performance offers little margin for a direct improvement, and the utilization of advanced materials in many components of the nozzle present no specific problems as compared with those of other parts of the engine, with the exception of the petals, in which the introduction of ceramic materials has a direct influence on cooling and performance, and it is included in the cooling optimization. The problem of optimization of the actuation system was discussed earlier, mainly in connection with the utilization of a one versus two parameter actuation system. Since that time SENDER and ITP have carried out many studies and tests on actuation systems and on cooling optimization. They also have accumulated experience by means of theoretical and experimental studies on the utilization of ceramic petals. Some results and the main conclusion of these studies and tests are presented in this paper.
Author
Convergent-Divergent Nozzles; Cooling Systems; Actuators; Optimization; Nozzle Geometry; Ceramic Matrix Composites

19960054440 Societe Nationale d'Etudes et de Construction de Moteurs Aeronautiques, Control and Accessories Div., Moissy-Cramayel, France
AN ADVANCED CONTROL SYSTEM FOR TURBOFAN ENGINE: MULTIVARIABLE CONTROL AND FUZZY LOGIC (APPLICATION TO THE M88-2 ENGINE)
Garassino, Alain, Societe Nationale d'Etudes et de Construction de Moteurs Aeronautiques, France; Bois, Patrick, Societe Nationale d'Etudes et de Construction de Moteurs Aeronautiques, France; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The search for better performance of present and future turbofan engines involves an increase in the number of variable geometries and thus of control loops. As we can not, or do not, want to disregard the interaction between loops any more, the future control systems will therefore be multivariable. The aim of the architecture of multivariable control presented here is to optimize a performance index during transients. This architecture consists of an inner loop which optimizes the performance index taking into account the limitations, an outer loop which brings the nominal steady-state offsets to zero, and a trajectory that takes into account the topping schedule limitation. This basic architecture can be improved by a fuzzy supervisor. Indeed, two control outputs are generated according to the description mentioned above. The first one optimizes the thrust and does not care very much about the low pressure stall (LPS) margin limitation. The second one optimizes again the thrust and strongly takes the LPS margin limitation into account. The fuzzy logic then provides for a compromise between these two control outputs according to the engine state. Simulation results showing the efficiency of the method are presented.
Author
Fuzzy Systems; Multivariable Control; Turbofan Engines; Aerodynamic Stalling; Linear Quadratic Regulator; Control Systems Design; Optimal Control; Thrust Control

19960054441 Defence Research Agency, Propuslion Technology Dept., Farnborough, United Kingdom
MULTIVARIABLE CONTROL OF MILITARY ENGINES
Dadd, G. J., Defence Research Agency, UK; Sutton, A. E., Defence Research Agency, UK; Greig, A. W. M., Defence Research Agency, UK; Advanced Aero-Engine Concepts and Controls; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper reviews research into the multivariable control (MVC) of aircraft powerplants; illustrating that MVC offers a potential for

tighter and more responsive control of conventional aircraft engine operations. Tools and methods have been established to support technical demonstrations of flight capable multivariate controls in variable cycle engine (VCE) and advanced short take-off and and vertical landing (ASTOVL) propulsion systems.
Derived from text
Aircraft Engines; V/STOL Aircraft; Variable Cycle Engines; Propulsion System Performance; Multivariable Control; Control Systems Design; Aircraft Control

19960054442 Turbomeca S.A. - Brevets Szydlowski, Microturbo Div., Bordes, France
ADVANCED CONTROL SYSTEM FOR A TURBINE ENGINE *SYSTEME DE REGULATION AVANCE POUR TURBOMOTEUR*
Frealle, J. L., Turbomeca S.A. - Brevets Szydlowski, France; Jun. 1996; 14p; In French; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The appearance of full authority digital electronic control (FADEC)-type regulations for helicopter turbine engines in recent years has considerably enriched the engine control function. Helicopter usage has been made easier and the pilot's workload reduced, with the engine and power transmission train being automatically maintained within their limits. Maneuverability of the helicopter has been improved by rotor speed regulation performance features. The opportunity for strict management of engine emergency operating conditions, greatly superior to continuous maximum conditions, has led to considerable improvements in the performance parameters of two-engine helicopters in one engine inoperative (OEI) situations. Functions that will help in pilot training for this breakdown configuration are integrated into the control functions.
AIP
Emergencies; Engine Control; Helicopter Engines; Gas Turbine Engines; Control Systems Design; Rotor Speed; Speed Control

19960054443 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Engineering Div., Moissy-Cramayel, France
CONTRIBUTION OF DYNAMIC ENGINE SIMULATION TO MILITARY TURBOFAN CONTROL SYSTEM DESIGN AND DEVELOPMENT
Pierre, Laurent, Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Duponchel, Jean-Pierre, Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Gerard, Pierre, Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes dynamic simulations of transient performances applicable to modern military engines. This document is dedicated to the diverse tasks conducted regarding dynamic engine behavior control that are to be solved using an analytical process that relies on dynamic simulations of the engine and its systems. The main features of the engine transient model, its real-time version, and the identification tools that ensure evolution of the features are presented. Some applications are: the interpretation of tests (determination of in-situ compressor surge line position, analysis of engine response during flight testing, etc.); the design of control laws (effect of dynamics of a given element on the engine response, assessment of the response of the most critical engine).
Derived from text
Control Systems Design; Turbofan Engines; Engine Control; Dynamic Control; Real Time Operation; Computerized Simulation; Propulsion System Performance

19960054444 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Control and Accessories Div., Moissy-Cramayel, France
NEURAL ADAPTIVE CONTROL OF AN ENGINE EXHAUST NOZZLE
Garassino, Alain, Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Advanced Aero-Engine Concepts and Controls; Jun. 1996; 8p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This work deals with the application of neural techniques to control a turbofan engine exhaust nozzle area. The process exhibits strong non-linearities and thus it is difficult to control with classical methods. Neural networks are used with an approach inspired by indirect adaptive control. The neural controller consists of two neural networks which communicate with each other. One achieves the identification task while the other controls the nozzle area. The simulation results of the process with a neural controller are given and compared with current results. The neural controller is better than the classical one and leads to a significant improvement in engine performance. Furthermore, the method can be used easily to control any non-linear dynamic system.
Author
Adaptive Control; Turbofan Engines; Exhaust Nozzles; Neural Nets; Control Systems Design

19960054445 Army Research Lab., Vehicle Propulsion Direcorate, Cleveland, OH United States
ADAPTIVE OPTIMIZATION OF AIRCRAFT ENGINE PERFORMANCE USING NEURAL NETWORKS
Simon, Donald L., Army Research Lab., USA; Long, Theresa W., NeuroDyne, Inc., USA; Jun. 1996; 14p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Preliminary results are presented on the development of an adaptive neural network based control algorithm to enhance aircraft engine performance. This work builds upon a previous NASA effort known as performance seeking control (PSC), an adaptive control algorithm that contains a model of the aircraft propulsion system which is updated on-line to match the operation of the aircraft's actual propulsion system. The neural network based adaptive control, like PSC, will contain a model of the propulsion system that will be used to calculate optimal control commands on-line. It is hoped that it will be able to provide some additional benefits above that provided by PSC. Since the PSC algorithm is computationally intensive, it is valid only at near steady-state flight conditions and has no way to adapt or learn on-line, these issues are being addressed in the development of the optimal neural controller. Specialized neural network processing hardware is being developed to run the software. The algorithm will be valid at steady-state and transient conditions, and will take advantage of the on-line learning capability of neural networks. Future plans call for the testing of the neural network software and hardware prototype against an aircraft engine simulation.
Author
Adaptive Control; Aircraft Engines; Algorithms; Network Control; Neural Nets; Control Systems Design; Propulsion System Performance

19960054446 Wright Lab., Wright-Patterson AFB, OH United States
DISTRIBUTED ARCHITECTURES FOR ADVANCED ENGINE CONTROL SYSTEMS
Lewis, T. J., Wright Lab., USA; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The goals of the Integrated High Performance Turbine Engine Technology (IHPTET) initiative demand that controls and accessories (C/A) weight, acquisition cost, and support cost be significantly reduced for modern gas turbine engines. Distributed control technology is one of the few approaches that has the potential to effect reductions in all three categories. Weight can be reduced by replacing the traditionally complex full authority digital electronic control (FADEC) and heavy harness assembly with light-weight distributed processing elements interconnected via a simple communication and power distributing bus. Simplification of FADEC interfaces makes off-engine mounting feasible, enabling an acquisition cost reduction that is greater than the cost increase incurred by adding electronics to engine sensors and actuators. Distributing intelligence throughout the engine will improve the control system's ability to isolate faults. The resulting reductions in time to troubleshoot and unnecessary component removals will decrease maintenance costs. Since high temperature electronics are the key to the viability of the distributed control concept, recent developments in this area are reviewed.
Author
Aircraft Engines; Active Control; Engine Control; Engine Design; Gas Turbine Engines; Cost Reduction; Distributed Parameter Systems; Electronic Control

19960054447 Fiat Aviazione S.p.A., Control Design, Turin, Italy
SAFETY CRITICAL SOFTWARE DEVELOPMENT FOR ADVANCED FULL AUTHORITY CONTROL SYSTEMS
Tortarolo, Franco, Fiat Aviazione S.p.A., Italy; Crosetti, Guido, Fiat

Aviazione S.p.A., Italy; Difilippo, Carmine, Fiat Aviazione S.p.A., Italy; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper focuses on the experience gained during the specification and development of the system development environment and its subsequent use for the safety critical software for the European Fighter aircraft engine (EJ2000) fully automated digital electronic controls (FADECs) where performance, reliability, testability, and maintainability have equal priority. It concentrates on the methodologies and tools employed during each software development phase with particular emphasis on safety related techniques.

Author

Fighter Aircraft; Engine Design; Computer Aided Design; Electronic Control; Safety Factors; Propulsion System Performance; Control Systems Design; Specifications; Standards

19960054448 Pratt and Whitney Aircraft, Government Engines and Space Propulsion, West Palm Beach, FL United States

REVIEW OF PHOTONIC SYSTEM DEVELOPMENT FOR PROPULSION CONTROLS

Birdsall, J. C., Pratt and Whitney Aircraft, USA; Fields, C. V., Pratt and Whitney Aircraft, USA; Agnello, M., Naval Air Warfare Center, USA; Jun. 1996; 6p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The use of photonics on aircraft gas turbine engines offers weight savings, electromagnetic interference (EMI) immunity, and performance benefits for engine control systems. For these reasons, fly-by-light technology is being developed for use in future aircraft control systems. Full authority digital electronic control (FADEC) systems that are compatible with fly-by-light aircraft and that use fiber optics on the engine for sensing and control are under development at United Technologies Corporation. Pratt and Whitney has made progress in transitioning fiber optics sensors, harnesses and optro-electronic FADEC (OEF) interfaces to engine demonstration programs. This paper discusses the benefits of photonic propulsion control systems, describes the components of an opto-electronic engine control system, provides results from on-engine testing, presents lessons learned and discusses areas that require additional development to achieve technology readiness for product transition.

Author

Aircraft Engines; Gas Turbine Engines; Engine Control; Fly by Light Control; Interference Immunity; Photonics; Electronic Control

19960054449 Institute for Aerospace Research, Structures, Materials and Propulsion Lab., Ottawa, Ontario Canada

MODELLING OF A FUEL CONTROL UNIT FOR SMALL GAS TURBINE ENGINES FEATURING INTERACTING ELECTRONIC LINEAR ACTUATORS

Georgantas, A. I., Institute for Aerospace Research, Canada; Krepec, T., Concordia Univ., Canada; Cheng, R. M. H., Concordia Univ., Canada; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper investigates an electic fuel control unit for small gas turbine engines, with valves operated by linear digital actuators. The unit is based on the modified metering section of a conventional hydro-mechanical fuel control unit. A mathematical model of the system is first developed and validated by experimentation. It is subsequently used for simulation and further study of the system dynamics. It was demonstrated that this new system features greater functional flexibility and faster transient response than the conventional system. The possibility for back-up, in case of failure of one valve also is discussed.

Author

Gas Turbine Engines; Transient Response; Actuators; Control Equipment; Engine Design; Fuel Control; Fuel Valves; Engine Failure

19960054450 Defence Research Agency, Flight Dynamics and Simulation Dept., Bedford, United Kingdom

THE VAAC HARRIER PROGRAMME: FLYING STOVL WITH 1-INCEPTOR CONTROL

Shanks, G. T., Defence Research Agency, UK; Scorer, F. J., Defence Research Agency, UK; Advanced Aero-Engine Concepts and Controls; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Active control technology (ACT), as applied to modern conventional take-off and landing (CTOL) aircraft has been extended to integrate the flight and propulsion control systems of a Harrier aircraft. This extension allows the direct control of all the forces generated on the aircraft, but it is the control concepts and management options, that are under investigation. An experimental integrated flight and propulsion system (IFPC) has completed Phase 1 flight trials and has demonstrated consistent pilot workload reduction for the recovery task. Comparisons between different methods of controlling the aircraft, including a 1-inceptor option, are presented and the implications for the technology on the engine power off-take for hover control is discussed.

Author

Active Control; Control Theory; Harrier Aircraft; V/STOL Aircraft; Workloads (Psychophysiology); Propulsion System Performance; Aircraft Control; Control Systems Design

19960054451 Pratt and Whitney Aircraft, West Palm Beach, FL United States

INTEGRATED FLIGHT AND PROPULSION CONTROL SIMULATION TOOLS FOR ADVANCED AIRCRAFT AND PROPULSION SYSTEMS

Sobanski, Kurt J., Pratt and Whitney Aircraft, USA; Khalid, Irfan, Pratt and Whitney Aircraft, USA; Advanced Aero-Engine Concepts and Controls; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper discusses the accomplishments and benefits of the PROLIFIC, a tool set for the development and evaluation of an integrated flight and propulsion control (IFPC) system for flight critical applications. The material presented focuses on IFPC development tools for present and future military tactical aircraft. These tools are required to develop and thoroughly verify all propulsion system components prior to flight. Propulsion control systems become flight critical for aircraft configurations such as short take-off and vertical landing (STOVL) and reduced tail area aircraft with thrust vectoring engine nozzles. As aircraft flight control systems become more coupled with propulsion systems, so does the need for highly integrated control laws and associated development tools such as PROLIFIC.

Derived from text

Aircraft Engines; Flight Control; Propulsion System Configurations; Thrust Vector Control; V/STOL Aircraft; Control Systems Design; Software Development Tools

19960054452 NASA Lewis Research Center, Cleveland, OH United States

INTEGRATED FLIGHT AND PROPULSION CONTROLS FOR ADVANCED AIRCRAFT CONFIGURATIONS

Merrill, Walter, NASA Lewis Research Center, USA; Garg, Sanjay, NASA Lewis Research Center, USA; Jun. 1996; 10p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The research vision of the NASA Lewis Research Center in the area of integrated flight and propulsion controls technologies is described. In particular, the integrated method for propulsion and airframe controls developed at the Lewis Research Center is described including its application to an advanced aircraft configuration. Additionally, future research directions in integrated controls are described.

Author

Aircraft Configurations; Propulsion System Configurations; Systems Integration; Research Facilities; Control Systems Design; Aircraft Engines; Computerized Simulation

19960054453 Wright Lab., Wright-Patterson AFB, OH United States

PROPULSION INTEGRATION ISSUES FOR ADVANCED FIGHTER AIRCRAFT

Gridley, Marvin C., Wright Lab., USA; Walker, Steven H., Wright Lab., USA; Jun. 1996; 12p; In English; See also 19960054418; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes a baseline inlet system with respect to propulsion integration technologies. Previous operational inlet designs maximized total pressure recovery, minimized distortion at the engine face, and minimized overall frontal observables. Current budgetary realities have caused a shift in the technology development approach to maintaining current levels of inlet system aerodynamic performance at a reduced life cycle cost and/or increased aircraft utility. The current USAF inlet technology development goals for the year 2000 include: a decreased inlet weight by 50% from current base-

lines, a decreased inlet volume by 50% from current baselines, and maintain or increase current inlet performance levels. The baseline inlet system is the current state-of-the-art in inlet systems technology, a caret inlet aperture with a long, serpentine subsonic diffuser. This design provides for high aerodynamic performance and survivability throughout the tactical fighter envelope.
Derived from text
Aerodynamic Characteristics; Engine Inlets; Inlet Airframe Configurations; Inlet Nozzles; Aircraft Design; Life Cycle Costs; Nozzle Geometry; Technology Utilization

19970009254 Daimler-Benz Aerospace A.G., Military Aircraft, Munich, Germany
INLET AND PROPULSION INTEGRATION OF RAM PROPELLED VEHICLES
Bissinger, N. C., Daimler-Benz Aerospace A.G., Germany; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 46p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The design of intakes and afterbodies for hypersonic vehicles with RAM air breathing propulsion systems is described. The aerodynamic aspects of the integration of the forebody with the intake and the afterbody with the nozzle are outlined. The potentials and deficits of modern available tools are demonstrated and a strategy for the design of the propulsion system for a hypersonic vehicle is proposed.
Author
Propulsion System Configurations; Afterbodies; Air Intakes; Ramjet Engines; Computational Fluid Dynamics; Flow Visualization; Navier-Stokes Equation; Wind Tunnel Tests

19970009255 NASA Lewis Research Center, Cleveland, OH United States
INLET AND PROPULSION INTEGRATION OF SCRAM PROPELLED VEHICLES
Povinelli, Louis A., NASA Lewis Research Center, USA; Oct. 1996; 22p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The material to be presented in these two lectures begins with cycle considerations of the turbojet engine combined with a ramjet engine to provide thrust over the range of Mach 0 to 5. We will then examine in some detail the aerodynamic behavior that occurs in the inlet operating near the peak speed. Following that, we shall view a numerical simulation through a baseline scramjet engine, starting at the entrance to the inlet, proceeding into the combustor and through the nozzle. In the next segment, we examine a combined rocket and ramjet propulsion system. Analysis and test results will be examined with a view toward evaluation of the concept as a practical device. Two other inlets will then be reviewed: a Mach 12 inlet and a Mach 18 configuration. Finally, we close our lectures with a discussion of the Detonation Wave engine, and inspect the physical and chemical behavior obtained from numerical simulation. A few final remarks will be made regarding the application of CFD for hypersonic propulsion components.
Author
Systems Integration; Turbojet Engines; Mach Number; Air Intakes; Hypersonic Speed; Computerized Simulation; Supersonic Combustion Ramjet Engines; Propulsion System Performance

19980018675 Johns Hopkins Univ., Applied Physics Lab., Laurel, MD United States
HYPERSONIC AIR-BREATHING MISSILE PROPULSION
Waltrup, Paul J., Johns Hopkins Univ., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 22p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A comparison of the performance of storable, liquid hydrocarbon fueled, scramjet-powered axisymmetric missile configurations using several types of fuel piloting/ fuel pre-preparation methods are presented along with an initial methodology to permit these comparisons to be made. The merits of each engine type are discussed, and a first attempt at defining an upper flight Mach number bound on these types of engines is presented.
Author
Hypersonic Flight; Air Breathing Engines; Missile Configurations; Propulsion; Supersonic Combustion Ramjet Engines; Hydrocarbons

19980018676 Aerospatiale Missiles, Bourges, France
SCRAMJET AND DUAL MODE RAMJETS
Bouchez, Marc, Aerospatiale Missiles, France; Falempin, Francois, Office National d'Etudes et de Recherches Aerospatiales, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 10p; In French; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Airbreathing sustained hypersonic flight could have operational advantages for military applications. by an other way, airbreathing propulsion could have a potential interest for the future reusable launcher, in connection with rocket engines. High speed ramjets (scramjet and dual mode ramjet) are a key technology for these two kinds of military or space future applications. Airbreathing launcher using scramjet have been recently studied in France within the scope oi PREPHA program. The chosen concept, which seems to be the most power full and robust, is a dual mode ramjet, associated with rocket engines completely separated. More generally, the use of scramjets for launchers is typically associated with hydrogen as a fuel, a maximum airbreathing Mach number of 12, and reusability. Less energetic fuels could also be used in dual fuel ramjets to take benefit of their higher density.
Author
Supersonic Combustion Ramjet Engines; Ramjet Engines; Air Breathing Engines; Hypersonic Flight; Military Technology; Reusable Launch Vehicles; Rocket Engines

19980018677 Bayern-Chemie G.m.b.H., Aschau, Germany
CRITICAL PHYSICAL PHENOMENA IN SCRAMJET PROPULSION
Kurth, G., Bayern-Chemie G.m.b.H., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 12p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper gives a short overview about the critical physical phenomena occurring in scramjet propulsion systems. After the description of these phenomena, an engineering approach will be given to analyze and predesign scramjet combustion processes and complete scramjet propulsion system respectively.
Derived from text
Supersonic Combustion Ramjet Engines; Propulsion System Performance; Propulsion System Configurations; Combustion Chambers; Physical Factors

19980018678 NASA Lewis Research Center, Cleveland, OH United States
EVALUATION OF AN EJECTOR RAMJET BASED PROPULSION SYSTEM FOR AIR-BREATHING HYPERSONIC FLIGHT
Thomas, Scott R., NASA Lewis Research Center, USA; Perkins, H. Douglas, NASA Lewis Research Center, USA; Trefny, Charles J., NASA Lewis Research Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 12p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A Rocket Based Combined Cycle (RBCC) engine system is designed to combine the high thrust to weight ratio of a rocket along with the high specific impulse of a ramjet in a single, integrated propulsion system. This integrated, combined cycle propulsion system is designed to provide higher vehicle performance than that achievable with a separate rocket and ramjet. The RBCC engine system studied in the current program is the Aerojet strutjet engine concept, which is being developed jointly by a government-industry team as part of the Air Force HyTech program pre-PRDA activity. The strutjet is an ejector-ramjet engine in which small rocket chambers are embedded into the trailing edges of the inlet compression struts. The engine operates as an ejector-ramjet from takeoff to slightly above Mach 3. Above Mach 3 the engine operates as a ramjet and transitions to a scramjet at high Mach numbers. For space launch applications the rockets would be re-ignited at a Mach number or altitude beyond which air-breathing propulsion alone becomes impractical. The focus of the present study is to develop and demonstrate a strutjet flowpath using hydrocarbon fuel at up to Mach 7 conditions.
Author
Air Breathing Engines; Hypersonic Flight; Ejectors; Ramjet Engines; Propulsion; Rocket Engines; Hypersonic Speed; Engine Design; Cycles

19980018679 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
CONCEPT OF A COMBUSTION CHAMBER AND THE INJECTION SYSTEMS *CONCEPTION DE LA CHAMBRE DE COMBUSTION ET DES SYSTEMES D'INJECTION*
Scherrer, D., Office National d'Etudes et de Recherches Aerospatiales, France; Bouchez, M., Aerospatiale, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 18p; In French; See also 19980018672; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Conception of a combustion chamber and as system of injection of a hypersonic stator reactor are presented to cover three aspects: (1) Conception of the combustion chamber supplied with hydrogen and analysis of the method of functioning Mach 5 and 7.5; (2) Concepts of the injectors of a super stator reactor supplied with hydrogen; and (3) Specific problems posed by the use of hydrocarbon supplies.
Author
Injection; Hydrogen; Hypersonic Speed; Stators

19980018681 Motoren- und Turbinen-Union G.m.b.H., Munich, Germany
ACTIVE COOLING OF FULLY VARIABLE HYPERSONIC SERN NOZZLES
Lederer, R., Motoren- und Turbinen-Union G.m.b.H., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 6p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Within the last few years MTU has made a great development effort towards high-speed nozzle design, manufacturing, hot-gas testing and test analysis as part of the German Hypersonics Technology Programme. Within the framework of this programme two actively cooled nozzles were designed, fabricated and tested in 1993 and 1995, respectively. Whereas the first nozzle was cooled with cryogenic hydrogen, gaseous hydrogen was used for the latter. In this paper the associated nozzle design, fabrication and test effort will be described and highlighted. Focus will be placed on the experience gained by testing the actively cooled, fully variable nozzle structures.
Author
Hypersonic Nozzles; Nozzle Design; Fabrication; Hydrogen; High Temperature Gases; Cryogenics

19980018691 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
TEST FACILITIES FOR BASIC RESEARCH ON PROPULSION *INSTALLATIONS D'ESSAIS POUR LES RECHERCHES FONDAMENTALES EN PROPULSION*
Collin, G., Office National d'Etudes et de Recherches Aerospatiales, France; Dessornes, O., Office National d'Etudes et de Recherches Aerospatiales, France; Magre, P., Office National d'Etudes et de Recherches Aerospatiales, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 12p; Summary translated by Schreiber; In French; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Two test facilities for hydrogen combustion in supersonic air flow were developed in the context of studies on superathodyds [ramjet]. One is dedicated to basic studies of reactive supersonic mixture layers; the other one deals with the evaluation of concepts of injection and of combustion chamber. These facilities and the related instruments are described. Initial results demonstrate their capacity to produce supersonic combustion flows and to supply data on the inflammation time and on the elementary injectors.
Derived from text
Combustible Flow; Hydrogen; Supersonic Flow; Combustion Chambers; Test Facilities; Ramjet Engines

19980018697 Pyrodyne, Inc., New Market, MD United States
OVERVIEW OF PROPULSION PERFORMANCE
Billig, Frederick S., Pyrodyne, Inc., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 12p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Nearly forty years have passed since the concept of the supersonic combustion ramjet, scramjet, was first introduced. At that time, the exciting potential of airbreathing propulsion for both expendable missiles and highly efficient space launch systems were proposed. Conceptual vehicle designs, engine flowpaths, including methods for injection and flame stabilization, and estimates of cycle performance were developed. Calculations were made for typical climb and cruise trajectories which showed distinct advantages of the scramjet over all-rocket powered systems. In the intervening years, prior to the initiation of the National Aero-Space Plane (NASP), a significant technology data base had been established which had substantiated the levels of performance that had been predicted by the pioneers. Nonetheless, no system utilizing the scramjet propulsion system had been developed. On every occasion, when a selection between a scramjet and an all-rocket system had been made, the all-rocket has prevailed. Paradoxically, the NASP, which was to be a single stage access to orbit vehicle, never was required to consider an all-rocket-powered alternative. Unfortunately, NASP failed to meet its stated objectives, in part due to unforeseen limitations of the propulsion cycle, and the program was cancelled. It is prudent to examine the underlying reasons for both the decision to cancel NASP and the reluctance to select scramjets for other applications.
Derived from text
Propulsion; Supersonic Combustion Ramjet Engines; National Aerospace Plane Program; Air Breathing Engines; Spacecraft Launching; Rocket Engines

19980033528 General Electric Co., Aircraft Engines, Cincinnati, OH United States
BALANCING AFFORDABILITY AND PERFORMANCE IN AIRCRAFT ENGINES
Williams, J. C., General Electric Co., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 6p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The historical measure of performance of an aircraft gas turbine engine has been simply the thrust it produces divided by its weight (T/W). While this measure is still appropriate, as the aircraft engine has matured, the rate of change of thrust to weight has begun to decrease and other factors such as costs have become increasingly important relative to performance. Therefore, it can be argued today that performance should have a broader, more comprehensive definition that includes other factors such as durability and reliability. Further, most modern military aircraft have some degree of "signature" treatment incorporated into the system. "Signature" is the radar (RF) or infrared (IR) signal that either emanates from or is created by an aircraft that allows its detection. The F-117 and B-2 systems are well known examples of low signature or "stealthy" systems. It is neither appropriate nor relevant to discuss signature control technology in detail here, but it is important to mention several points in connection with this subject. First, signature control is accomplished through a combination of the use of special design methods and materials with special physical properties. Second, any form of signature treatment adds weight and cost to the system. Third, the engine inlet and exhaust structures are a significant source of signature (both RF and IR) and require special attention if a given level is to be achieved. These areas of a system also represent the interface between the engine and the airframe and the responsibility for them typically is shared between the airframe and the engine manufacturers. Finally, retention of low signature usually requires additional maintenance and this also affects the affordability of a system.
Derived from text
Aircraft Engines; Gas Turbine Engines; Balancing; Costs; Durability; Reliability

19980033529 Wright Lab., POTA, Wright-Patterson AFB, OH United States
REDUCING COSTS FOR AIRCRAFT GAS TURBINE ENGINES
Skira, Charles A., Wright Lab., USA; Philpot, Mike, Defence Research Agency, UK; Hauvette, Jacquesa, Societe Nationale d'Etudes et de Construction de Moteurs Aeronautiques, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 10p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Current military budget constraints are highlighting the cost issues in procuring and maintaining adequate defense forces. Aircraft and their engines are typical examples where costs are more and more expensive from one generation to the other. However, at the same time, it is recognized that the correlated increase in performance is necessary to keep the pace with the potential of adverse weaponry.

Due to the historic and dramatic changes in recent global events, the USA military services have been undergoing a drawdown in size. Since 1989, our military forces have been reduced by 30%. Over this period of declining budgets the DoD has slowed down the modernization of our forces in order to concentrate on maintaining force readiness and quality of life. However, by the year 2010, more than half of the US Air Force fighter fleet will consist of existing F-15's, F-16's and F-117A's, well beyond the expected service life of these systems. DoD and other defense departments must address the modernization of their forces to ensure readiness into the next century. This modernization will only be possible within the era of reduced defense budgets when the S&T community begins to focus on increasing the effectiveness of a user-identified capability while decreasing the costs of the necessary technology, and improving material through planned upgrades.
Derived from text
Aircraft Engines; Gas Turbine Engines; Cost Reduction; Service Life

19980035010 Alenia Aeronautica, Alenia Flight Test, Turin, Italy
ALENIA APPROACH TO EF2000 PROPULSION SYSTEM FLIGHT TEST: METHODOLOGY AND TEST RESULTS
Bellero, Lucio, Alenia Aeronautica, Italy; Dogliatti, Francesco, Alenia Aeronautica, Italy; Girolami, Claudio, Alenia Aeronautica, Italy; Dec. 1997; 12p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

EUROFIGHTER 2000 is a single seat, aerodynamically unstable delta-canard fighter aircraft which embodies latest technologies in structures, systems, engine and avionics. The aircraft is powered by two EJ 200, a new engine specifically tailored to meet EF2000 mission requirements. Eurofighter Jagdflugzeug GmbH consortium is the prime contractor for the development of the complete weapon system. It is composed of the four national aircraft companies involved in the program, namely British Aerospace (BAe), Daimler-Benz Aerospace (DASA), Alenia (ALN) and CASA . Within this program, Alenia is tasked (among the other responsibilities) with the propulsion system development, that has been initially flight-tested by Alenia prototype DA3; it has been the first one fitted with the new EJ200 engines (built by Eurojet consortium). DA7, the second Alenia prototype, will be tasked (among other tasks like avionics/navigation testing) of final aircraft/engines performance verification. The first phase of the development programme has been successfully completed and the following phase, with the uprated engines standard, is already in progress. This paper summarizes: (1) the overall EF2000 flight test philosophy; (2) the approach to EJ200 engine flight test, including relight; (3) test organization, test methods, flight test instrumentation, data analysis, data management and (4) early test results.
Author
Propulsion; Flight Test Instruments; Fighter Aircraft; Engine Tests

19980035011 Centre d'Essais en Vol, Base d'Essais d'Istres, Istres, France
FLIGHT TICKET M 88-2 ***BON DE VOL M 88-2***
Nicolet, Eric, Centre d'Essais en Vol, France; Dec. 1997; 10p; In French; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The M88-2 is the engine installed in the multi-purpose fighter Rafale. The in-flight qualification method of the regulation consists of having a representative engine of the worst engine mass produced and to verify that its performance is sound, within all aspects of flight.
Author
Fighter Aircraft; Engine Noise; Performance Tests

19990014382 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
AGEING ENGINES
Immarigeon, Jean-Pierre, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 131-132; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Because of the high acquisition cost of military aircraft and the diminishing resources for new equipment acquisitions, many aircraft from NATO nations are likely to be kept in service longer than originally intended. The task of achieving life extension while ensuring the high levels of safety and reliability established in the past, will present formidable challenges. From the time an aircraft is put in service, components from both the airframe and engine(s), undergo a process of damage accumulation which may take many forms and is influenced by usage severity. The long term effects of service induced damage are not always well understood, nor are they well documented, particularly for high time vehicles. The damage can affect both the performance and structural integrity of airframe and engine components. Designers and operators alike need to take into consideration this aging process for ensuring continued safety and reliability of the vehicles.
Derived from text
Aircraft Engines; Engine Parts; Long Term Effects; Aging (Biology); Service Life

08
AIRCRAFT STABILITY AND CONTROL

19950024650 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik., Brunswick, Germany
HANDLING QUALITIES ANALYSIS ON RATE LIMITING ELEMENTS IN FLIGHT CONTROL SYSTEMS
Hanke, Dietrich, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel Workshop on Pilot Induced Oscillations; Feb 1, 1995, 18 p; In English; See also 19950024640; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

Rate saturation conditions caused by rate limiting elements (RLE's) in flight control systems can contribute to severe pilot induced oscillation. In order to gain more theoretical insight in this problem the paper deals with the development of rate limiter describing functions in order to establish a theoretical basis for open and closed loop handling qualities analysis in the frequency domain. Although rate limitation produces nonlinear system behaviour it could be shown that rate limiter describing functions could be applied to existing methods used in handling qualities analysis of pilot/aircraft systems. A new handling quality parameter, the rate limiter onset frequency, is defined as a measure of input amplitude and frequency. Here the onset frequency in reference to the system bandwidth could be a suitable parameter in defining handling qualities boundaries for flight control systems with RLE's. The response in amplitude and phase is presented for different types of input signals such as triangle and sinusoidal oscillations. Rate limiter cascading is considered, too. Further, the suitability of various existing handling quality criteria are compared with the RLE results especially with respect to PIO. Finally, the improvements in system behavior by applying an alternate control scheme (ACS), as proposed by A'Harrah, will be discussed.
Derived from text
Aircraft Control; Aircraft Design; Amplitudes; Control Systems Design; Flight Control; Frequency Ranges; Frequency Response; Parameter Identification

19950025568 Advisory Group for Aerospace Research and Development, Flight Mechanics Panel, Neuilly-Sur-Seine, France
ACTIVE CONTROL TECHNOLOGY: APPLICATIONS AND LESSONS LEARNED ***LES TECHNOLOGIES DU SYSTEME DE CONTROLE ACTIF: APPLICATIONS ET ENSEIGNEMENTS***
Jan 1, 1995; 400p; In English; In French; See also 19950025569 through 19950025596
Report No.(s): AGARD-CP-560; ISBN 92-836-0007-X; Copyright Waived; Avail: CASI; A17, Hardcopy; A04, Microfiche

In the last decade, Active Control Technology (ACT) has emerged from the realm of theory and modest experimental applications to full-scale use on production aircraft, while more elaborate forms of ACT are under test for the future production of aircraft. New technologies have been applied in military fighters to maximize maneuverability and agility, and in civil transports to reduce trim drag, lower pilot workload and improve riding qualities. During this symposium the status of Active Control Technology was assessed in light of the experience gained over the last decade. The symposium was organized around four sessions comprising 28 technical papers in all. These sessions focused on: Specifications for flight control design, Design and analysis methods, System integration and Implementation of experience.
Active Control; Conferences; Flight Control; Technology Assessment

19950025569 Hoh Aeronautics, Inc., Lomita, CA, United States
THE ROLE OF HANDLING QUALITIES SPECIFICATIONS IN FLIGHT CONTROL SYSTEM DESIGN
Hoh, Roger H., Hoh Aeronautics, Inc., USA; Mitchell, David G., Hoh Aeronautics, Inc., USA; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 12 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The handling qualities specification should be an essential element of the flight control system design and testing for an active control technology (ACT) aircraft. This is a significant departure from previous conventional aircraft where handling qualities depended more on the configuration (tail size, control surface sizing, etc.). The necessity for incorporating the handling qualities specification into the flight control system design process has not been recognized by the industry, as evidenced by the fact that most of the ACT aircraft do not meet the requirements of the current handling qualities specification. This has resulted in excessive phase lag in the flight controls, and numerous cases of pilot induced oscillation. This paper reviews key handling qualities criteria for ACT aircraft as well as lessons that should be incorporated into specification upgrades and flight control design efforts.
Author
Active Control; Control Systems Design; Controllability; Flight Control; Pilot Induced Oscillation

19950025570 Gibson (J. C.), Saint Annes, United Kingdom
THE PREVENTION OF PIO BY DESIGN
Gibson, J. C., Gibson (J. C.), UK; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 12 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Control problems caused by poor pilot-aircraft closed loop characteristics have existed for as long as aircraft have been flown. The majority of them have been the result of excessive response amplitudes and phase lags conflicting with simple stability margin requirements. Their solutions have been rather straightforward and often amount to the provision of K/S-like responses, or sufficiently similar, within the bandwidths of interest. Most high order Pilot Induced Oscillation (PIO) problems have-been introduced, not by more complex fly by wire control laws, but by unnecessary lags or sometimes by excessive gain placed between the pilot and the response. The pilot is forced to operate in a region of excessive phase lag and response gain, typically with the impression that the aircraft is not actually responding to the commands. The solutions address the provision of adequate stability margins in much the same way as in earlier problems. The high order PIO problem is identified in the open loop attitude behavior in the uniquely defined PIO frequency region, in which the response lags the stick by 180 degrees or more. It is not necessary to model the pilot, who is found to operate in a synchronous manner with the attitude oscillation. The dominant feature in this is the rate zero crossing which acts to trigger the reversals of the control input. The input itself may take the form of a sinusoid, a relay switching action, or a mixture of the two. A number of simple criteria can be applied to control law design which have been found to ensure the prevention of high order PIO. The existence of a PIO problem can be identified with great certainty before flight by specific test methods, which should be applied with rigor no matter how much confidence exists in the design methods. Finally, it is crucial for all concerned to understand that if the underlying problem is there, no matter how extreme the pilot inputs may have to be to excite it, then it can be expected to happen in flight. It will be impossible to prevent it by pilot briefings.
Derived from text
Aircraft Control; Aircraft Stability; Flight Control; Pilot Induced Oscillation; Prevention; Time Dependence; Time Lag

19950025571 McDonnell-Douglas Aerospace, Long Beach, CA, United States
THE IMPORTANCE OF FLYING QUALITIES DESIGN SPECIFICATIONS FOR ACTIVE CONTROL SYSTEMS
Hodgkinson, J., McDonnell-Douglas Aerospace, USA; Rossitto, K. F., McDonnell-Douglas Aerospace, USA; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 15 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The first part of this paper consists of recollections of how some of the flying qualities specifications for active control fighters emerged. These recollections include some lessons learned. The second part, with these recollections and lessons as motivation, introduces new data on the much more recent developments in active control transports.
Author
Active Control; Control Systems Design; Flight Control

19950025572 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik., Brunswick, Germany
EXPERIENCES WITH ADS-33 HELICOPTER SPECIFICATION TESTING AND CONTRIBUTIONS TO REFINEMENT RESEARCH
Ockier, C. J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Pausder, H.-J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 20 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The introduction of Active Control Technology in rotorcraft created the need for new handling qualities requirements. In response to this, a new helicopter handling qualities specification was developed under the leadership of the U.S. Army and published as Aeronautical Design Standard 33 (ADS-33). Since its introduction, research has been conducted to expand the handling qualities database on which ADS-33 is based. This paper presents DLR contributions to this research. A standard BO 105 was used to evaluate the applicability and repeatability of the current ADS-33C criteria in forward flight. As a result of this study, some data gaps were recognized and the criteria that need further verification were identified. The in-flight simulator ATTHeS was used for an investigation of the effects of bandwidth and phase delay and pitch-roll coupling on helicopter handling qualities in a high gain slalom tracking task. Results are shown that indicate a need to more tightly constrain the phase delay for the roll axis than in the current ADS-33 requirements. For the pitch-roll coupling criterion it is shown that although the format of the current ADS-33 requirements is valid for control and rate coupling, it cannot be used for coupling types typical of actively controlled helicopters. A frequency domain criterion that offers more comprehensive coverage of all types of pitch-roll coupling is proposed.
Author
Active Control; Aircraft Specifications; Controllability; Flight Control; Flight Simulators; Helicopter Control

19950025573 Israel Aircraft Industries Ltd., Flight Operations., Ben-Gurion Airport, Israel
LAVI FLIGHT CONTROL SYSTEM: DESIGN REQUIREMENTS, DEVELOPMENT AND FLIGHT TEST RESULTS
Shmul, Menahem, Israel Aircraft Industries Ltd., Israel; Erenthal, Eli, Israel Aircraft Industries Ltd., Israel; Attar, Moshe, Israel Aircraft Industries Ltd., Israel; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 13 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The flight control system of the Lavi Multimission fighter is described. The control laws design philosophy is given along with the control laws development, the flying qualities requirements and the final structure of the pitch axis (DFCS). The simulation phase is covered along with special control laws features. The question 'how does the Lavi fly?' is addressed. Problems uncovered during flights, and solutions found, are detailed and the flying qualities data are given. Finally, the program status is explained.
Author
Aircraft Performance; Aircraft Specifications; Control Systems Design; Fighter Aircraft; Flight Control; Flight Tests

19950025574 Technische Univ., Dept. of Aerospace Engineering., Delft, Netherlands
ROBUST CONTROL: A STRUCTURED APPROACH TO SOLVE AIRCRAFT FLIGHT CONTROL PROBLEMS
Bennani, S., Technische Univ., Netherlands; Mulder, J. A., Technische Univ., Netherlands; Bosgra, O. H., Technische Univ., Netherlands; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 24 p; In English; See also 19950025568; Sponsored by NAL; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper discusses an application of several robust control methodologies such as H(sub infinity) optimal control, micro-synthesis and gain scheduling via linear fractional transformations applied to a flight control system. to illustrate the approach, a design model for the short period approximation of the Cessna Citation 500 has been chosen, for which certain handling quality requirements have to be met over a large set of operating conditions. For all these methods, the design framework remains the same, only the system 'norm' changes to the object to be minimized. The paper shows how these methods work and illustrates the features of the new approach.
Author
Aircraft Control; Control Systems Design; Controllers; Flight Control; Linear Transformations; Optimal Control; Robustness (Mathematics)

19950025575 Honeywell, Inc., Minneapolis, MN, United States
DYNAMIC INVERSION: AN EVOLVING METHODOLOGY FOR FLIGHT CONTROL DESIGN
Enns, Dale, Honeywell, Inc., USA; Bugajski, Dan, Honeywell, Inc., USA; Hendrick, Russ, Honeywell, Inc., USA; Stein, Gunter, Honeywell, Inc., USA; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 12 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes nonlinear dynamic inversion as an alternative design method for flight controls. The method is illustrated with super-maneuvering control laws for the F-18 High Angle-of-Attack Research Vehicle (HARV).
Author
Control Systems Design; Flight Control; Inversions; Maneuverability; Nonlinearity

19950025576 Office National d'Etudes et de Recherches Aerospatiales, Dept. d'etudes et de Recherches en automatique., Toulouse, France
EVALUATION OF THE TECHNIQUES OF FUZZY CONTROL FOR THE PILOTING AN AIRCRAFT *EVALUATION DES TECHNIQUES DE CONTROLE FLOU POUR LE PILOTAGE D'AVION*
Imbert, N., Office National d'Etudes et de Recherches Aerospatiales, France; Piquerau, A., Office National d'Etudes et de Recherches Aerospatiales, France; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 10 p; In French; See also 19950025568; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The characteristic of a fuzzy controller is to use a knowledge expressed in natural language in the forms of expert rules to calculate the value of the control starting from the numerical information from the sensors. The implementation of such a pilot requires the interpretation of the numerical field symbolically and reciprocally. This is carried out by the use of fuzzy assemblies. The associated theory allows starting from consideration of precise measurement, the whole of the stated expert rules, and choice of suitable operators to deduce a value from control. It results in a particular structure of the fuzzy controllers, whose main characteristics are the subject of the first part of the presentation. The implementation on the example of the longitudinal pilot control of an aircraft is then presented. Two approaches were adopted: the first uses the rules of manual piloting formulated in natural language by the 'experts' who are the pilots. The second uses the laws resulting from a conventional autopilot to build rules of piloting. The results are presented in the perspective from a comparison between the two types of controllers, conventional or fuzzy.
Transl. by CASI
Aircraft Control; Control Systems Design; Controllers; Flight Control; Fuzzy Systems; Knowledge Based Systems; Knowledge Representation

19950025577 Wright Lab., Wright-Patterson AFB, OH, United States
THE CONTROL SYSTEM DESIGN METHODOLOGY OF THE STOL AND MANEUVER TECHNOLOGY DEMONSTRATOR
Moorhouse, David J., Wright Lab., USA; Citurs, Kevin D., McDonnell-Douglas Aerospace, USA; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 11 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper documents the development of a full-envelope Integrated Flight/Propulsion Control system. A combination of classical and multivariable design methodologies was used, including a unique inverse procedure to produce second-order equivalent systems meeting specified flying qualities requirements. The implementation was based on a rational choice between the two methodologies. It is suggested that a parallel design approach in the beginning will produce efficient convergence on a practical optimum design. Finally, all control law revisions should be done analytically and only evaluated by simulation. Regardless of the design technique used, the process begins by specifying detailed design guidelines selected to meet the intent of MIL-F-8785C. Once the designs were complete and analyzed based on the design guidelines, manned flight simulation was used only to validate and demonstrate the flying qualities achieved prior to flight test. Problems encountered during simulation or flight testing were addressed first by reviewing the original design guidelines and evaluating the success achieved in implementing them.
Derived from text
Aircraft Specifications; Control Systems Design; Flight Control; Flight Tests; Short Takeoff Aircraft

19950025578 Aeronautica Macchi S.p.A., Varese, Italy
CONTROL LAW DESIGN USING H-INFINITY AND MU-SYNTHESIS SHORT-PERIOD CONTROLLER FOR A TAIL-AIRPLANE
Mangiacasale, L., Aeronautica Macchi S.p.A., Italy; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 11 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The recently developed methods H-infinity and mu-Synthesis are used in the design of a control law for a tail controlled unstable airplane. The design procedure has been applied with success and seems to be very promising in order to solve control design problems in real applications. The (H-infinity) + mu controller, characterized by a very large order (namely 34th), has been successfully reduced to one having order 5th with a very low decay in the overall performance. The reduced-order controller meets all the servo technical specifications demanded to the full-order one. At present it is under test as part of a 6-DoF simulation program to verify its real robustness in face of structured and unstructured perturbations.
Author
Aircraft Control; Aircraft Specifications; Control Systems Design; Controllability; Controllers; Design Analysis; Flight Control

19950025579 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik., Brunswick, Germany
MODEL FOLLOWING CONTROL FOR TAILORING HANDLING QUALITIES: ACT EXPERIENCE WITH ATTHES
Bouwer, Gerd, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Vongruenhagen, Wolfgang, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Pausder, Heinz-Juergen, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 15 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

In-flight simulators will play an important and unique role in the development process of future helicopter systems and in generating credible handling qualities data which establish design guides for the integrated helicopter systems including sophisticated cockpit technologies and high authority control systems. The Institute for Flight Mechanics of DLR has developed the helicopter in-flight simulator ATTHeS (Advanced Technology Testing Helicopter System) which is based on a BO 105 helicopter. The testbed is equipped with a full authority nonredundant fly-by-wire control system for the main rotor and a fly-by-light system for the tail rotor. In the simulation mode the testbed requires a two-man crew, a simulation and a safety pilot. The onboard computer system consists of two computers to which are assigned the separated tasks, data collection and digital control system. With the implemented software structure the flexibility is achieved to change the control laws without any changes in the real time process. Before undergoing any flight test with a new or modified control system, a real-time hardware/software-in-the-loop ground-based simulation has to be successfully performed. For the purposes of in-flight simulation an explicit model following control system was developed and the model following performance was evaluated in flight. This control system is composed of a dynamic feedforward, based on an extended model of the host helicopter, and an optimized feedback control system. The capability and flexibility of ATTHeS has been demonstrated in different test programs which have been related

to the use of the testbed for test pilot training, handling qualities research, helicopter simulation, and control law design and evaluation including automatic navigation and hover position hold.
Author
Active Control; Airborne/Spaceborne Computers; Control Systems Design; Controllability; Flight Control; Flight Simulation; Flight Simulators; Fly by Wire Control; Helicopter Control; Optimal Control

19950025580 NASA Hugh L. Dryden Flight Research Center, Edwards, CA, United States
X-29 FLIGHT CONTROL SYSTEM: LESSONS LEARNED
Clarke, Robert, NASA Hugh L. Dryden Flight Research Center, USA; Burken, John J., NASA Hugh L. Dryden Flight Research Center, USA; Bosworth, John T., NASA Hugh L. Dryden Flight Research Center, USA; Bauer, Jeffrey E., NASA Hugh L. Dryden Flight Research Center, USA; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 15 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Two X-29A aircraft were flown at the NASA Dryden Flight Research Center over a period of eight years. The airplanes' unique features are the forward-swept wing, variable incidence close-coupled canard and highly relaxed longitudinal static stability (up to 35-percent negative static margin at subsonic conditions). This paper describes the primary flight control system and significant modifications made to this system, flight test techniques used during envelope expansion, and results for the low- and high-angle-of-attack programs. Throughout the paper, lessons learned will be discussed to illustrate the problems associated with the implementation of complex flight control systems.
Author
Control Systems Design; Flight Control; Flight Tests; X-29 Aircraft

19950025581 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Flight Mechanics., Brunswick, Germany
ADVANCED GUST MANAGEMENT SYSTEMS: LESSONS LEARNED AND PERSPECTIVES
Koenig, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Hahn, K.-U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Winter, J., Dornier Luftfahrt G.m.b.H., Germany; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 17 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Aircraft operations at low altitudes often are affected by strong gusts and turbulence producing additional aerodynamic forces and moments. This results in extra aircraft accelerations and therefore in an unpleasant impact on passenger comfort and pilot workload as well as in extra structural loads. Active Control Technology is able to suppress these effects partly. The knowledge about the potential for improvement, the parameters of influence and the performance requirements for such gust alleviation systems is still quite small. Since the mid-seventies Dornier and DLR (Institute of Flight Mechanics) have been working together on BMFT programs developing systems to improve the ride quality in gusty weather. The developed Open-Loop Gust Alleviation System OLGA was investigated through dynamic wind tunnel experiments and flight-tested onboard the experimental aircraft Do 128 TNT. This research was continued by DLR developing the Load Alleviation and Ride Smoothing System LARS using the modified VFW 614 aircraft ATTAS (Advanced Technologies Testing Aircraft System). The Deutsche Aerospace Dornier Luftfahrt GmbH has concentrated on simulation studies for their aircraft types Do 228 and Do 328. The presented paper provides a brief description of the advantages of overall gust management systems considering lift, drag and pitch control. The following topics will be presented in detail: (1) the basic flight mechanics of gust load alleviation; (2) the design of integrated gust management systems; (3) simulation and flight test results; and (4) lessons learned and general perspectives.
Author
Aerodynamic Forces; Flight Operations; Flight Tests; Gust Loads; Low Altitude; Stability Derivatives; Turbulence

19950025583 Dornier Luftfahrt G.m.b.H., Friedrichshafen, Germany
AUTOMATIC FLIGHT CONTROL SYSTEM FOR AN UNMANNED HELICOPTER SYSTEM DESIGN AND FLIGHT TEST RESULTS
Weidel, M., Dornier Luftfahrt G.m.b.H., Germany; Alles, W., Dornier Luftfahrt G.m.b.H., Germany; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, p 10; In English; See also 19950025568; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The use of unmanned air vehicles (UAV) in support of the Navy from small ships to fulfill tasks such as reconnaissance of large areas will succeed only if the user gains a high amount of confidence in the reliable operation of such a system, especially during the take off and landing phase. Take off from and landing on small landing pads on aviation facility ships in all-weather conditions prefer the application of VTOL-UAV's (Vertical Take Off and Landing) with a coaxial rotor system. Manual take off and landing procedures which have to be applied during operational service both at day time and at night under all-weather conditions and ship motions overtax the service personnel already at low sea states. This fact requires automatic take off and landing procedures. The German Ministry of Defence commissioned Dornier (DASA) in November 1990 with the development, test and demonstration of an automatic take off and landing system on the basis of the Gyrodyne QH-50 drone helicopter in order to prove the feasibilty of such a system in general. The essential ship and sea state dependent motions of the landing pad - roll, pitch and heave - were simulated with a ship deck simulator. The customer's requirement consisted of ten automatic take offs and landings of the UAV from a 4 by 4 meters landing pad. The test and demonstration phase was performed on the airfield of Friedrichshafen in the presence of experts from several NATO-Countries by the end of 1991.
Derived from text
Automatic Flight Control; Flight Tests; Helicopter Design; Landing Aids; Pilotless Aircraft; Systems Engineering; Vertical Landing

19950025584 British Aerospace Defence Ltd., Military Aircraft Div., Preston, United Kingdom
THE FCS-STRUCTURAL COUPLING PROBLEM AND ITS SOLUTION
Caldwell, B. D., British Aerospace Defence Ltd., UK; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 13 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Implementation of ACT in aircraft is now almost routine, and often essential in realizing performance requirements. However, unless a proactive and thorough approach is taken to ensuring that the effects of the flexibility of the airframe structure and its interaction with the FCS (Flight Control System) are analyzed and accounted for, costly development delays and control system redesigns may ensue. This paper is intended to discuss the basis of the phenomenon referred to at BAe Warton as FCS-Structural Coupling, the evolution of the methodology evolved at Warton to ensure freedom from its effects, and the development directions required to advance the state of art in this field.
Author
Aircraft Structures; Airframes; Control Surfaces; Control Systems Design; Flight Control

19950025585 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany
STRUCTURAL ASPECTS OF ACTIVE CONTROL TECHNOLOGY
Hoenlinger, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Zimmermann, H., Deutsche Aerospace A.G., Germany; Sensburg, O., Deutsche Aerospace A.G., Germany; Becker, J., Deutsche Aerospace A.G., Germany; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 25 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A survey on the structural relevant applications of Active Control Technology is presented. The benefits and disadvantages of various active control systems for transport and fighter aircraft are discussed. The problem of adverse structural coupling is addressed and possible solutions are outlined. The Smart Structure Technology offers new applications for active control technology, but to exploit the full potential of this technology multidisciplinary design methods have to be improved.
Author
Active Control; Control Surfaces; Control Systems Design; Feedback Control; Smart Structures; Structural Design; Technology Utilization

19950025588 Alenia Aeronautica, Flight Mechanics Group., Turin, Italy
DIGITAL AUTOPILOT DESIGN FOR COMBAT AIRCRAFT IN ALENIA
Tonon, Aldo, Alenia Aeronautica, Italy; Belluati, Pier Luigi, Alenia Aeronautica, Italy; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 13 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

ALENIA - Aeronautica has been involved in Digital Autopilot design for the AMX and EF 2000 programs. The AMX is a subsonic attack aircraft whose Flight Control System is based on Fly-by-wire technology, incorporating an Hybrid Analog and Digital Flight Control Computer for Control and Stability augmentation in pitch, roll and yaw axes, which guarantees the aircraft capability of full performance; in addition the Flight Control System has also a conventional mechanical back-up in the pitch and roll axes, which guarantees aircraft safe re-entry after failure of both hydraulic and both electrical circuits. The paper deals with the development history of the AMX autopilot through design to flight test. In particular the paper addresses the design to specification relationship, the system development and clearance process and the flight test results. The EF 2000 programme is an international development for an agile, highly unstable Fly-by-Wire Air Superiority fighter. Within the EF 2000 consortium ALENIA has the responsibility for Basic Autopilot design. This design, currently in the early stages of development, poses peculiar problems due to the interaction of Autopilot (external) feedback loops and the basic stabilization (inner) loops. The paper address these peculiar aspects in conjunction with the specific design methodologies applied.
Author
Automatic Pilots; Control Systems Design; Digital Systems; Fighter Aircraft; Flight Control; Fly by Wire Control; Systems Engineering

19950025589 British Aerospace Defence Ltd., Warton, United Kingdom
EXPERIMENTAL AIRCRAFT PROGRAMME (EAP): FLIGHT CONTROL SYSTEM DESIGN AND TEST
Mccuish, A., British Aerospace Defence Ltd., UK; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 14 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The objectives of the Experimental Aircraft Programme were to demonstrate various technologies relevant to a future combat aircraft within the rigors imposed by having to achieve flight clearance and demonstration. Prime areas for demonstration, among others, were modern cockpit displays, avionics systems integration, advanced material construction, advanced aerodynamics and active flight control. Nearly all future combat aircraft will have an unstable basic airframe due to the advantages that are accrued: smaller, lighter, aerodynamically more efficient, etc. Necessary to such an aircraft is a full time active control system. This paper outlines the philosophy and method taken to design the flight control laws and relates their development through the life of the programme. The experience gained from the three phase, 259 flight test programme is summarized. The success of the flight programme has provided a wealth of experience from the operation of the aircraft. In particular, and most impressive to the pilots, was the carefree handling capability; this was considered remarkable. A further success was the complete absence of pilot induced oscillation (PIO) tendency throughout the whole of the flight programme.
Author
Active Control; Avionics; Control Systems Design; Fighter Aircraft; Flight Control; Flight Tests; Systems Integration

19950025590 Air Force Flight Test Center, Edwards AFB, CA, United States
AN INVESTIGATION OF PILOT INDUCED OSCILLATION PHENOMENA IN DIGITAL-FLIGHT CONTROL SYSTEMS
Flynn, William A., Air Force Flight Test Center, USA; Lee, Robert E., Air Force Flight Test Center, USA; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 6 p; In English; See also 19950025568; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper summarizes the results of a technical review of pilot induced oscillations (PIO) in aircraft equipped with digital flight control systems. A review of the causes of PIO, the specific interaction of digital flight control systems, and an evaluation of the flight control development process was conducted. The paper discusses the highlights of the technical review and the recommendations for future development of flight control systems to reduce the occurrences of handling qualities problems in general and PIO in particular.
Author
Control Stability; Control Systems Design; Digital Systems; Flight Control; Pilot Induced Oscillation

19950025591 British Aerospace Defence Ltd., Aerodynamics Dept., Warton, United Kingdom
FLIGHT DEMONSTRATION OF AN ADVANCED PITCH CONTROL LAW IN THE VAAC HARRIER AIRCRAFT
Fielding, C., British Aerospace Defence Ltd., UK; Gale, S. L., Defence Research Agency, UK; Griffith, D. V., Defence Research Agency, UK; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 12 p; In English; See also 19950025568; Sponsored by UK Ministry of Defence; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

'Vectored thrust Aircraft Advanced flight Control' (VAAC) is a UK project, sponsored by the Ministry of Defence and managed by the Defence Research Agency (DRA). The project is investigating, through ground-based simulation and flight test on the VAAC Harrier research aircraft, the low speed flight control, handling and cockpit display concepts applicable to an aircraft replacing the Harrier. As part of the project, British Aerospace Defence Limited have designed a revolutionary two-inceptor pitch plane control law for assessment on the project aircraft. This Control Law has now been flight tested and further developed 'in-flight' by the DRA, culminating in a series of successful flight demonstrations to guest pilots. During the latter stages of flight testing the Control Law was modified to allow single-inceptor operation. Flight testing has shown that both the two- and single-inceptor control strategies result in a large reduction in pilot workload, when compared with the VAAC Harrier's three-inceptor arrangement, during the transition from wing-borne to jet-borne flight and hover. This paper describes the Control Law's evolution from initial concept through to the results obtained from flight testing.
Author
Aircraft Control; Control Theory; Flight Control; Flight Tests; Harrier Aircraft; Pitch (Inclination); Thrust Vector Control

19950025593 Boeing Defense and Space Group, Helicopters Div., Philadelphia, PA, United States
ADVANCED FLIGHT CONTROL TECHNOLOGY ACHIEVEMENTS AT BOEING HELICOPTERS
Landis, Kenneth H., Boeing Defense and Space Group, USA; Dabundo, Charles, Boeing Defense and Space Group, USA; Davis, James M., Boeing Defense and Space Group, USA; Keller, James F., Boeing Defense and Space Group, USA; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 16 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Over the last two decades, flight control system requirements have been in a state of transition. Rotary wing missions have become more demanding, requiring vehicle management systems capable of conducting highly aggressive missions under night / adverse-weather conditions in severe electromagnetic environments. The digital, fly-by-wire / optics control system technologies developed at Boeing Defense and Space Group, Helicopters Division to meet these air vehicle requirements are overviewed. These technologies, which integrate digital multimode control laws and sidestick controllers within redundant-reconfigurable architectures, provide the rotorcraft capabilities required for the 21st century. The advances in flight control design, as developed during various technology demonstrator programs and applied in production of the V-22 Osprey tiltrotor and the RAH-66 Comanche scout / attack helicopter, are summarized.
Author
Control Systems Design; Control Theory; Digital Systems; Flight Control; Fly by Wire Control; Helicopters

19950025594 National Research Council of Canada, Flight Research Lab., Ottawa Ontario, Canada
PRACTICAL EXPERIENCES IN CONTROL SYSTEMS DESIGN USING THE NCR BELL 205 AIRBORNE SIMULATOR
Baillie, Stewart W., National Research Council of Canada, Canada; Morgan, J. Murray, National Research Council of Canada, Canada;

Goheen, Kevin R., National Research Council of Canada, Canada; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 12 p; In English; See also 19950025568; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The objective of this paper is to describe a variety of examples of control system design and application on the NRC Bell 205 Airborne Simulator. For background, this paper will first examine the physical characteristics of the Bell 205 and the mathematical models which have been developed to describe them. The paper then reviews the classical control design techniques which have been used to develop high bandwidth rate and attitude response type systems on the aircraft, and describes the empirically determined fixes which have become standard elements of these types of systems. to complete the paper, two sections will deal with application of modern control theories; the first describes a limited effort to develop a translational rate command system using a six degree of freedom model of the Bell 205 and a publicly available software package, MATLAB/Simulink. The second modern control theory section deals with a more detailed study performed in collaboration with Carleton University and supported by DND/CRAD to devise modern control theory controllers for the Bell 205. All discussions of the paper are substantiated with actual in-flight validation data to clearly demonstrate design successes and failures. Author

Applications Programs (Computers); Attitude Control; Bell Aircraft; Control Systems Design; Control Theory; Flight Simulators; Flight Stability Tests; Helicopter Control

19950025595 Aerospatiale, Handling Qualities Dept., Toulouse, France

FLYING QUALITIES OF CIVIL TRANSPORT AIRCRAFT WITH ELECTRICAL FLIGHT CONTROL *LES QUALITIES DE VOL DE AVIONS DE TRANSPORT: CIVIL A COMMANDES DE VOL ELECTRIQUES*

Chatrenet, D., Aerospatiale, France; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 5 p; In French; See also 19950025568; Copyright; Avail: CASI; A01, Hardcopy; A04, Microfiche

This conclusion to the the conference covers the flying qualities and flight control systems (FCS) of transport aircraft equipped with electrical flight control systems, as seen by Aerospatiale. A retrospective look at the related technological developments over the past 25 years precedes a comparison between the Airbus A340 and A320. The main points in the differences between the FCS in the A320 and the A340 are associated with the compensation effects of the more flexible structure of the A340, its design for long-range ('minimum drag'), and the inherent limitations in take-off performance.

Derived from text

A-320 Aircraft; A-340 Aircraft; Aircraft Control; Electric Control; Flight Control

19950025596 British Aerospace Defence Ltd., Military Aircraft Div., Preston, United Kingdom

PILOT INDUCED OSCILLATION: A REPORT ON THE AGARD WORKSHOP ON PIO

Mckay, K., British Aerospace Defence Ltd., UK; AGARD, Active Control Technology: Applications and Lessons Learned; Jan 1, 1995, 10 p; In English; See also 19950025568; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Instability of the pilot/airframe combination has been a problem from the beginning of manned flight. The rapid advances made in aviation following the Second World War greatly increased the incidence of PIO problems and led to a large amount of research and development work aimed at understanding and mitigating these difficulties. Criteria and requirements were developed which could be used in design to obtain satisfactory PIO qualities. Nevertheless, in spite of all this work, and even with the great flexibility in modern control technologies available to the designer, PIO problems still often occur with new aircraft; in fact it is the power and responsiveness of modern control systems which makes them susceptible to various 'non-linear' effects such as time delays, rate limits, actuator saturation, etc., leading to unexpected PIO difficulties. With current experience, it is clear that a universal solution of the PIO problem still evades the engineering community. The cost of these problems in programme delay and financial terms is significant. The gathering together of specialists to discuss this problem, from their various points of view, has led to positive gains in the state of knowledge regarding PIOs; it has provided a significant step toward their elimination and contributed to the avoidance of PIO associated programme costs and penalties. This paper provides an overview of the results from the Workshop. Fuller details are to be published by AGARD in the proceedings of the Conference and Workshop in the near future and in a separate Advisory Report. Author

Active Control; Aircraft Control; Aircraft Stability; Flight Control; Pilot Induced Oscillation

19960012292 Universitaet der Bundeswehr Muenchen, Neubiberg, Germany

FUNCTIONAL DEVELOPMENT AND FIELD TEST OF CASSY: A KNOWLEDGE-BASED COCKPIT ASSISTANT SYSTEM

Onken, R., Universitaet der Bundeswehr Muenchen, Germany; AGARD, Knowledge-Based Functions in Aerospace Systems; Nov 1, 1995, 22 p; In English; See also 19960012290; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper presents the functional concept and development of the cockpit assistant system CASSY, based on basic requirements for effective man/machine interaction. This system was developed in order to enhance flight safety and mission effectiveness. The time has come that cockpit systems will no longer be designed on a vague basis of specifications. The advances in technology provide the necessary basis to systematically reflect requirements for human-centered automation into clear-cut specifications and system design. CASSY is developed as a knowledge-based system. It has been extensively tested in flight simulators as well as field tested in the ATTAS (Advanced Technologies Test Aircraft System) of the DLR. Some of the results of these flight trials will be presented in this paper. The development was conducted by the University of the German Armed Forces, Munich with some support by DASA. Author

Aircraft Guidance; Aircraft Instruments; Expert Systems; Flight Instruments; Flight Safety

19960012293 Dassault Aviation, Saint-Cloud, France

DEVELOPMENT ENVIRONMENT FOR KNOWLEDGE-BASED SYSTEMS. SOME EXAMPLES OF APPLICATION: THE COPILOTE ELECTRONIQUE PROJECT

Champigneux, G., Dassault Aviation, France; AGARD, Knowledge-Based Functions in Aerospace Systems; Nov 1, 1995, 10 p; In English; See also 19960012290; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper aims at describing first lessons learnt in terms of engineering guidelines and development methodology within the french project called 'Copilote Electronique' of an Electronic Crew Member System. This project is lead by Dassault Aviation with the support of French official services (DRET, STTE) and involves several industrial and scientific partners (SAGEM, Dassault Electronique, Matra Defense, Sextant Avionique, IMASSA). The French 'Copilote Electronique' project started in 1986 through various preliminary studies and since 1994 it has taken a larger scale under the form of an exploratory development. Before the start of this development, advantages and drawbacks of existing software engineering or knowledge acquisition methodologies were compared. Emphasis was put on ergonomics design rules and on a project life cycle adaptation aiming at insuring better responses to pilots demands and fears. Building on the first year experience of the exploratory development phase of the Copilote Electronique project, we express confidence for successful operational evaluations.

Derived from text

Automatic Pilots; Expert Systems; Knowledge Bases (Artificial Intelligence); Product Development

19960020829 Aerospatiale, Toulouse, France

FLIGHT FLUTTER TESTS OF TRANSPORT CIVIL AIRCRAFT WITH AN ELECTRONIC FLIGHT CONTROL SYSTEM *ESSAIS EN VOL DE FLOTTEMENT SUR AVIONS DE TRANSPORT CIVIL MUNIS DE COMMANDES DE VOL ELECTRIQUES*

Lacabanne, M., Aerospatiale, France; Nov. 1995; 14p; In French; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The strategy used at Aerospatiale when performing flight clearance tests of modern civil aircraft equipped with Electronic Flight Control Systems (EFCS), particularly if the aircraft is prone to adverse interactions between the structural modes of the aircraft and the flight control system, is presented in the paper. Because of the potential for

adverse interactions it is shown that, in addition to the classical flutter tests, it is necessary to check the inflight dynamic behavior of the aircraft with EFCS operating at various flight conditions. The following topics are discussed in the paper: the choice of excitation devices; the description of recorded parameters; the importance of preflight analyses; the choice of flight conditions and configurations to be tested; and the correlation between the analytical model and the flight test modal analysis results. The paper also provides examples of aeroservoelastic flight test results.
Author
Flight Tests; Flutter; Transport Aircraft; Electronic Control; Flight Control; Civil Aviation; Structural Vibration

19960020834 Daimler-Benz Aerospace A.G., Military Aircraft Div., Munich, Germany
AEROSERVOELASTIC DESIGN, TEST VERIFICATION AND CLEARANCE OF AN ADVANCED FLIGHT CONTROL SYSTEM
Becker, J., Daimler-Benz Aerospace A.G., Germany; Vaccaro, V., Alenia, Italy; Nov. 1995; 16p; In English; See also 19960020814; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The design of notch filters is based upon a model of the aircraft describing the coupled flight dynamic, flight control dynamics and structural dynamic behavior, and on ground and in flight structural coupling tests. The paper outlines design procedures, design and clearance requirements, correlation between model predictions and structural coupling tests and model update for on ground and in flight.
Author
Flight Control; Aeroservoelasticity; Unsteady Aerodynamics; Flight Tests; Digital Filters; Finite Element Method; Grid Generation (Mathematics); Military Aircraft; Dynamic Control; Dynamic Models

19960022348 National Aerospace Lab., Amsterdam, Netherlands
PARAMETRIC IDENTIFICATION OF TRANSONIC UNSTEADY FLOW CHARACTERISTICS FOR PREDICTING FLUTTER OF FIGHTER AIRCRAFT WITH EXTERNAL STORES
Meijer, Jos J., National Aerospace Lab., Netherlands; Cunningham, Atlee M., Jr., Lockheed-Fort Worth Co., USA; Feb. 1996; 16p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

An analysis of steady wind tunnel data, obtained for a fighter type aircraft, has indicated that shock-induced and trailing-edge separation play a dominant role in the development of Limit Cycle Oscillations (LCO) at transonic speeds. On the basis of these data a semiempirical LCO prediction method was developed. Its preliminary version has been applied to several configurations and has correctly identified those which have encountered LCO. It has already shown the potential for application early in the design process of new aircraft to determine and understand the nonlinear aeroelastic characteristics. In the present paper this method is upgraded on the basis of results of unsteady wind tunnel force and pressure measurements obtained from on oscillating fighter type wings. In particular, an aerodynamic nonlinear state-space model embedded in the LCO prediction method will be demonstrated. The developed aerodynamic model is a semi-empirical, unsteady, nonlinear model which makes use of these experimental steady and unsteady data. Validations are presented for various fighter configurations by comparing calculated LCO results with information from flight test data.
Author
Parameter Identification; Unsteady Flow; Transonic Flow; Aerodynamic Characteristics; Prediction Analysis Techniques; Flutter; Aircraft Configurations; Oscillating Flow

19970000623 Air Force Flight Test Center, Edwards AFB, CA United States
VARIABLE STABILITY IN-FLIGHT SIMULATOR TEST AIRCRAFT (VISTA)
Buehler, Kurt, Air Force Flight Test Center, USA; Reynolds, Phil, Calspan Corp., USA; Markman, Steve, Wright Lab., USA; Hellmann, Gary, Wright Lab., USA; Apr. 1996; 10p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The VISTA is the USA (US) of America's next generation in-flight simulator, replacing the aging NT-33. The VISTA is an F-16D with the Israeli Peace Marble 2 configuration. The flight control system has been extensively modified to create a state of the art in-flight simulator. The VISTA Phase 2 Development, Test and Evaluation (DT&E) at the Air Force Flight Test Center (AFFTC) started in July 1994 and was completed in January 1995. The flight test team consisted of personnel from the USA Air Force (USAF). Lockheed Fort Worth Company, and Calspan Corporation. The VISTA flew 62 test sorties for a total of 138 flight test hours at the AFFTC meeting or exceeding all design specifications. The VISTA is owned by Wright Laboratory's (WL) Flight Dynamics Directorate. The Calspan Corporation maintains and operates the VISTA for WL. Using the aerodynamic, mass, inertia, and controller characteristics, and the flight control laws of other aircraft, the VISTA can simulate the aircraft 'in-flight' determining the flying qualities and handling characteristics. The USAF and Navy Test Pilot Schools utilize the VISTA in their curriculum. The VISTA is available to support the USAF, other branches of the US Department of Defense, commercial aircraft development. National Aeronautics and Space Administration (NASA), and foreign military aircraft development programs. This paper presents a brief summary of the development of the VISTA, the hardware and softuare modifications that were made to create the VISTA, the VISTA Phase 2 flight test plan and results, and discusses the future direction of in-flight simulation.
Author
Flight Simulators; Flight Tests; Flight Control; Flight Characteristics; Control Theory; Aircraft Design

19970018628 Defence Research Establishment Valcartier, Courcellette, Quebec Canada
IMPROVED ENGAGEMENT ENVELOPE OF A TACTICAL MISSILE WITH AN INTEGRAL ROCKET/RAMJET ENGINE
Lauzon, M., Defence Research Establishment Valcartier, Canada; Subsystem Integration for Tactical Missiles (SITM) and Design and Operation of Unmanned Air Vehicles (DOUAV); Nov. 1996; 17p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A trade-off study on mission effectiveness identified definite benefits of the solid fuel integral-rocket-ramjet engine over the solid rocket motor for a medium-range air-to-air tactical missile. A six-degrees-of-freedom trajectory simulation model was first developed to assess the performance and operating envelope of the solid rocket motor and the ramjet engine for tactical air-to-air missile applications. The 6DOF simulation code includes a fully algebraic model for ramjet propulsion, a model for missile guidance based on the law of proportional navigation and a three-degrees-of-freedom target trajectory model. It can be used to evaluate missile kinematic performance and effectiveness against a maneuvering target. Results show that ramjet propulsion improves three important performance characteristics of a missile, namely, the time-of-flight (average velocity), maximum range and end-game maneuverability for longer range missions. The solid rocket motor, with its high thrust output and low burn time, gives the tactical missile a higher average velocity and hence a better maneuverability for shorter range engagements. A missile time-of-flight envelope with a non-maneuvering target at 10 km altitude shows that the IRR missile offers a time-of-flight advantage for launch ranges greater than 25-35 km and improves the missile maximum range capability by 40%. The IRR engine also extends the 3 g(sub n) maneuverability boundary by 50% in slant range.
Author
Integral Rocket Ramjets; Air to Air Missiles; Propulsion System Performance; Maneuverability; Computerized Simulation; Missile Ranges; System Effectiveness

19970018634 Aerospatiale Missiles, Chatillon, France
CONTROL OF A SUPERSONIC AIR TO GROUND MISSILE WITH VERY LIGHTLY DAMPED BENDING MODES
Friang, J. P., Aerospatiale Missiles, France; Bonnet, J. P., Aerospatiale Missiles, France; Duc, G., Ecole Superieure d'Electricite, France; Nov. 1996; 16p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In this paper, an autopilot is designed to control a missile with very lightly damped bending modes, using the loopshaping H(sub infinity) design procedure of McFarlane and Glover. Robustness in the face of large modelling uncertainties (including parameter and bending modes) is then investigated using real mu-analysis. The autopilot of the Bank to Turn (BTT) missile developed by AEROSPATIALE

(French Aerospace Industrial National Company) is finally validated on a non linear simulator: this will show the performances and the robustness of our design.
Derived from text
Automatic Control; Air to Surface Missiles; Automatic Pilots

19970019345 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
STICK AND FEEL SYSTEM DESIGN *SYSTEMES DE RESTITUTION DES EFFORTS AU MANCHE*
Gibson, J. C., Gibson (J. C.), UK; Hess, R. A., California Univ., USA; Mar. 1997; 180p; In English
Report No.(s): AGARD-AG-332; ISBN 92-836-1051-2; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

Since the earliest days of manned flight, designers have sought to assist the pilot in the performance of tasks by using stick and feel systems to bring these tasks within the bounds of human physical capabilities. This volume describes stick and feel systems in two parts. Part one describes the technologies which have been developed throughout the history of 20th Century aviation. Part two describes how modern systems dynamics interact with the human pilot. It is hoped that the design lessons and approaches outlined in this volume will contribute to a better understanding and appreciation of the importance of force-feel system design in aircraft/rotorcraft flight control.
Derived from text
Aircraft Control; Flight Control; Pilot Performance; Control Sticks; Control Theory; Man Machine Systems; Human Factors Engineering; Fly by Wire Control

19970025431 Westland Helicopters Ltd., Avionics and Systems Technology, Yeovil, United Kingdom
ADVANCES IN HELICOPTER CAREFREE HANDLING AND CONTROL AUGMENTATION
Massey, C. P., Westland Helicopters Ltd., UK; Howitt, J., Defence Research Agency, UK; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes research being undertaken by GKN Westland Helicopters and the UK Defence Research Agency (DRA) to examine enhanced augmentation of helicopter flight control systems. Current research is targeted at mechanical primary flight control systems with limited authority automatic flight control systems (AFCS) with a view towards early application as a retrofit to in-service helicopters or new versions of existing helicopters.
Author
Helicopter Control; Helicopters; Automatic Flight Control; Flight Control

19970025432 Eurocopter France, Marignane, France
ACTIVE CONTROL OF AEROMECHANICAL STABILITY
Krysinski, Tomasz, Eurocopter France, France; Apr. 1997; 26p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents the active control of aeromechanical stability as a powerful means of simplifying rotor design in future helicopters. The mathematical simulation model is presented and the results are compared to flight test data. The active control of ground resonance was fully validated with flight tests in the Super Puma Mk2 helicopter which behaved in a highly efficient and robust manner. An active control strategy is suggested for air resonance and drive train stability; a validation with flight tests is forecast in the near future. The proposed controls are simple and easy to integrate in a conventional Flight Control System (FCS). The actuators available in the current FCS are sufficient as far bandwidth required for active control of aeromechanical stability is concerned.
Author
Aerodynamic Stability; Helicopters; Control Stability; Active Control; Aerodynamic Characteristics

19970026414 Institute for Human Factors TNO, Soesterberg, Netherlands
DEVELOPMENT AND PERFORMANCE OF A COCKPIT CONTROL SYSTEM OPERATED BY VOICE
Steeneken, H. J. M., Institute for Human Factors TNO, Netherlands; Pijpers, E. W., National Aerospace Lab., Netherlands; Jun. 1997; 4p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The hands and eyes busy situation and high workload as is normally the case in a fighter cockpit require a natural means of communication between operator and system. Voice is an obvious means of communication, however the adverse cockpit conditions deteriorate the speech signal in such a way that automatic recognition of spoken commands is difficult. In this study the performance of a voice controlled cockpit was investigated. An automatic speech recognizer was integrated in the control system of a F-16 simulator. The performance was evaluated during representative operational simulated flights. A similar study was performed by Prevot and Onken (1995). The results indicate that a flexible syntax of the commands is required. The recognition performance (75%) of the connected command strings was not good enough to accommodate the pilots. From flight tests a representative spontaneous speech data base was collected for further improvements.
Author
Aircraft Instruments; Man Machine Systems; Voice Communication; Aircraft Pilots; Speech Recognition; Flight Tests; Voice Control

19970029339 NASA Langley Research Center, Hampton, VA United States
A COMPARISON OF PRESSURE MEASUREMENTS BETWEEN A FULL-SCALE AND A 1/16-SCALE F/A-18 TWIN TAIL DURING BUFFET
Moses, Robert W., NASA Langley Research Center, USA; Pendleton, Ed, Wright Lab., USA; Feb. 1997; 12p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

In 1993, tail buffet tests were performed on a full-scale, production model F/A-18 in the 80-by-120 Foot Wind Tunnel at NASA Ames Research Center. Steady and unsteady pressures were recorded on both sides of the starboard vertical tail for an angle of attack range of 20 to 40 degrees and at a sideslip range of -16 to 16 degrees at freestream velocities up to 100 knots (Mach 0.15, Reynolds number 1.23 x 10(exp 7)). The aircraft was equipped with removable leading edge extension (LEX) fences that are used in flight to reduce tail buffet loads. In 1995, tail buffet tests were performed on a 1/6-scale F-18 A/B model in the Transonic Dynamics Tunnel (TDT) at NASA Langley Research Center. Steady and unsteady pressures were recorded on both sides of both vertical tails for an angle-of-attack range of 7 to 37 degrees at freestream velocities up to 65 knots (Mach 0.10). Comparisons of steady and unsteady pressures and root bending moments are presented for these wind-tunnel models for selected test cases. Representative pressure and root bending moment power spectra are also discussed, as are selected pressure cross-spectral densities.
Author
Pressure Measurement; Tail Assemblies; Buffeting; Wind Tunnel Models; Wind Tunnel Tests; Free Flow; Aerodynamic Loads; Scale Models; Steady Flow; Bending Moments; F-18 Aircraft; Unsteady Flow; Full Scale Tests

19970029344 Daimler-Benz Aerospace A.G., Structural Dynamics, Loads Dept., Hamburg, Germany
IMPACT OF ELECTRONIC FLIGHT CONTROL SYSTEM (EFCS) FAILURE CASES ON STRUCTURAL DESIGN LOADS
Besch, H.-M., Daimler-Benz Aerospace A.G., Germany; Giesseler, H.-G., Daimler-Benz Aerospace A.G., Germany; Schuller, J., Daimler-Benz Aerospace A.G., Germany; Feb. 1997; 10p; In English; See also 19970029334; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

For structural design loads, the most relevant benefits of the advent of fly-by-wire and digital flight control systems are drawn from more sophisticated control of the aircraft and from the flight envelope protection functions. In parallel, rarely recognized even by the engineering community, the number of failure cases to be considered in A/C design is significantly increasing due to the growing complexity of the systems, eroding the aforementioned benefits. The monitoring system, designed to detect and to trigger removal of failure cases, can ease but not nullify the impact of failure cases on loads. Experience gained in the structural design of an A/C with fly-by-wire and digital flight control system is summarized, highlighting the necessity to cover system failures in calculating structural design loads. The current requirements for structural design of EFCS A/C are explained. by giving several examples of system failures of the new EFCS

technology, it will be demonstrated how the requirements are met, whereby the influence on structural loads is especially emphasized. Generic system-failure cases (software/ hardware) having an influence on structural loads, are runaway, jamming and oscillation of control surface(s), the latter we call Oscillatory Failure Cases (OFC). OFC's cause significant component loads and can cause resonance phenomena which may generate excessive loads for poorly damped rigid body and flexible modes. This motivated the research programme Oscillatory Failure Case Identification System (OFIS) which, as a future component of the common Monitoring Systems, aims at detection of OFC's in time. We describe the current status of OFIS that exploits the specific properties of OFC for detection enhancement. Furthermore, by investigating the inverse effect, namely, that structure loads have an influence on system layout (or modification), this presentation will underline the necessity, mentioned above, of co-operation between all disciplines in modern aircraft design.
Author
Aircraft Control; Fly by Wire Control; Aircraft Design; System Failures; Structural Design; Aircraft Structures; Electronic Control; Loads (Forces)

19980035029 Daimler-Benz Aerospace A.G., Military Aircraft Div., Manching, Germany
INVESTIGATIONS ON HANDLING QUALITIES AND AERODYNAMIC CHARACTERISTICS OF EUROFIGHTER 2000 AT DAIMLER-BENZ AEROSPACE FLIGHT TEST CENTRE
Oelker, Hans-Christoph, Daimler-Benz Aerospace A.G., Germany; Muthsam, Erfried W., Daimler-Benz Aerospace A.G., Germany; Dec. 1997; 12p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Currently the development flight test evaluation of EUROFIGHTER 2000 is under way. The present paper emphasizes on analysis methods for flight mechanical and aerodynamical evaluation suitable for a very agile, highly unstable fighter aircraft at DAIMLER-BENZ AEROSPACE flight test centre. Methods are summarized and illustrated with some representative results. Analysis methods in the time domain such as simulation of flown manoevres and in the frequency domain such as Z-transformation and Fourier analysis methods for system stability evaluations are presented. DASA's aerodynamic parameter identification method is presented. It resembles a unique equation decoupling approach to cope with the problems arising from the analysis of unstable aircraft. Representative results are given, which demonstrate the analysis capabilities of the presented methods.
Author
Qualitative Analysis; Aerodynamic Characteristics; Flight Tests; Fighter Aircraft

19980035030 Daimler-Benz Aerospace A.G., Flight Guidance and Control, Hamburg, Germany
FLIGHT TESTING OF MANUAL FLIGHT CONTROL FUNCTIONS FOR A SMALL TRANSPORT AIRCRAFT (PROJECT ATTAS-SAFIR)
Heintsch, Thomas, Daimler-Benz Aerospace A.G., Germany; Luckner, Robert, Daimler-Benz Aerospace A.G., Germany; Hahn, Klaus-Uwe, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Dec. 1997; 10p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In a technology programme DASA has developed Flight Control Laws (FCL) for an electronic flight control system of a small transport aircraft (100-seater). In a cooperation between DASA and DLR, the flight control functions were tested on DLR's VFW614/ATTAS test aircraft. This paper gives an overview of the flight control law development and testing within the SAFIR (Small Airliner Flight Control Law Investigation and Refinement) flight test project. Design objectives of the flight control system for the 100-seater are reviewed, a system overview is given, the flight control law functions are briefly explained and the development process is described. The testing procedure comprises the Small Airliner Flight Investigation and Refinement (SAFIR) experiment integration into the ATTAS test system, the definition of the flight tasks, the flight testing and the evaluation of the flight test results.
Author
Flight Tests; Electronic Control; Transport Aircraft

19980035031 NASA Dryden Flight Research Center, Edwards, CA United States
EVALUATION OF HIGH-ANGLE-OF-ATTACK HANDLING QUALITIES FOR THE X-31A USING STANDARD EVALUATION MANEUVERS
Stoliker, Patrick C., NASA Dryden Flight Research Center, USA; Bosworth, John T., NASA Dryden Flight Research Center, USA; Dec. 1997; 24p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The X-31A aircraft gross-acquisition and fine-tracking handling qualities have been evaluated using standard evaluation maneuvers developed by Wright Laboratory, Wright Patterson Air Force Base. The emphasis of the testing is in the angle-of-attack range between 30 deg. and 70 deg. Longitudinal gross-acquisition handling qualities results show borderline Level I/Level 2 performance. Lateral gross-acquisition testing results in Level I/Level 2 ratings below 45 deg. angle of attack, degrading into Level 3 as angle of attack increases. The fine tracking performance in both longitudinal and lateral axes also receives Level 1 ratings near 30 deg. angle of attack, with the ratings tending towards Level 3 at angles of attack greater than 50 deg. These ratings do not match the expectations from the extensive close-in combat testing where the X-31A aircraft demonstrated fair to good handling qualities maneuvering for high angles of attack. This paper presents the results of the high-angle-of-attack handling qualities flight testing of the X-31A aircraft. Discussion of the preparation for the maneuvers, the pilot ratings, and selected pilot comments are included. Evaluation of the results is made in conjunction with existing Neal Smith, bandwidth, Smith-Geddes, and military specifications.
Author
Evaluation; Angle of Attack; X-31 Aircraft; Flight Tests; Q Factors

19980202477 Air Force Research Lab., Wright-Patterson AFB, OH United States
INVESTIGATION OF BUFFET LOAD ALLEVIATION ON A SCALED F-15 TWIN TAIL MODEL
Huttsell, L. J., Air Force Research Lab., USA; Tinapple, J. A., Air Force Research Lab., USA; Weyer, R. M., Aeronautical Systems Div., USA; Mar. 1998; 8p; In English; See also 19980202469; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

One of the common problems on twin tail fighters operating at high angles of attack is buffet. The Air Force Research Laboratory Unsteady Aerodynamics Integrated Product Team (IPT) performed an experimental buffet investigation on a scaled F-15 model. The model was tested in the Subsonic Aerodynamic Research Laboratory (SARL) located at Wright Patterson AFB, Ohio. Phase I of this program characterized the buffet characteristics and investigated tangential blowing as a means of buffet suppression. Phase II will investigate the use of piezoelectric actuators on the flexible tail to suppress the structural response due to buffet. A numerical simulation of the rigid model was performed for a Mach number of 0.2, 24 degrees angle of attack, and 4 degrees of slideslip using an unstructured CFD (Computational Fluid Dynamics) code. A second computation was performed to evaluate engine mass flow effects. This paper will present the results of the buffet tests, the computational effort, and a comparison of the computational and test results.
Author
F-15 Aircraft; Computational Fluid Dynamics; Buffeting; Tangential Blowing; Unsteady Aerodynamics; Aerodynamic Loads; Scale Models; Vortices; Wind Tunnel Tests; Computerized Simulation; Aircraft Models; Unstructured Grids (Mathematics)

19980202480 British Aerospace Defence Ltd., Military Aircraft and Aerostructures, Brough, United Kingdom
FLUTTER PREDICTION FOR COMPLEX CONFIGURATIONS
Henshaw, M. J. deC., British Aerospace Defence Ltd., UK; McKiernan, D. D., British Aerospace Defence Ltd., UK; Mairs, C., British Aerospace Defence Ltd., UK; Mar. 1998; 8p; In English; See also 19980202469; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Flutter analysis requires the linking of structural deformation modeling with unsteady fluid dynamics; at British Aerospace, Aerospace Military Aircraft and Aerostructures (MA&A) a series of computational methods are used to model the various aspects of flutter to provide clearance data for aircraft. The various methodologies will be briefly described and the manner in which the parts of the

process interface outlined. Future aircraft require the tools to be capable of modelling complex configurations including novel planforms and aircraft with stores; these must also include the difficult transonic flow regime. The requirements of the unsteady methods needed to provide this capability and the manner in which they must be inserted into the existing process will be discussed. Initial results obtained using an unsteady Multiblock Euler method will be presented and the development of this method within the overall process will be detailed. These results will be used to illustrate the ways that sophisticated unsteady CFD methods must be developed, in terms of interface with structural components of the process, to meet project requirements for complex configurations. The post-processing requirements will also be presented.
Author
Computational Fluid Dynamics; Transonic Flutter; Flutter Analysis; Transonic Flow; Prediction Analysis Techniques; Aerodynamic Configurations; Mathematical Models; Euler Equations of Motion; Unsteady Aerodynamics

19990007852 Alenia Difesa, Avionic Systems and Equipment Div., Turin, Italy
AUTOPILOT SYNTHESIS FOR UNMANNED TACTICAL AIR VEHICLES (UTAV)
Faggion, P., Alenia Difesa, Italy; Zolla, L., Alenia Difesa, Italy; Jul. 1998; 8p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper presents an overview on the AutoPilot design philosophy for a medium class, jet powered Unmanned Tactical Air Vehicle (U.T.A.V,) and the development of its Rig + Advanced Integrated Data Acquisition & Simulation System (Rig + AIDASS). After a short description of the Mirach 150 U.T.A.V. system, the synthesis methodology of the primary control laws for the steering and navigational modes are presented (Autopilot and Flight Management System). The process aims at verifying accordance between requirements and performances of the global system (Autopilot+Airframe). The performances of the system are shown: dynamic responses in front of altitude, groundspeed and heading demands and their maintenance in presence of atmospheric turbulence (MIL-F-8785/C). The study is developed in FORTRAN 77 language.
Author
Flight Management Systems; Automatic Pilots; Pilotless Aircraft; Data Acquisition; Control Theory; Air Navigation; Systems Integration

19990007854 Bombardier, Inc., Defence Systems Div., Mirabel, Quebec Canada
AUTONOMOUS NAVIGATION AND CONTROL FUNCTIONS OF THE CL-327 VTOL UAV
Pelletier, M., Bombardier, Inc., Canada; Sakamoto, A., Bombardier, Inc., Canada; Tessier, C., Bombardier, Inc., Canada; Saintonge, G., Bombardier, Inc., Canada; Jul. 1998; 10p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The CL-327 vertical take-off and landing (VTOL) unmanned air vehicle has a payload carrying capability of 100 kg and an on-station endurance of 4.75 hours at 100 km (based on 50 kg payload). Although similar to that of the CL-227, the pitch, roll, yaw and height autopilots have been modified and improved to account for the capabilities and dynamics of the CL-327. The advanced guidance, navigation and control functions include GPS/DGPS-aided flight, waypoint guidance, automatic (vertical) take-off and landing as well as autonomous flight without the intervention from the surface element. Because of these and other advanced features, the CL-327 is the world's most advanced VTOL UAV in production today.
Author
Vertical Takeoff Aircraft; Pilotless Aircraft; Autonomous Navigation; Aircraft Control; Automatic Flight Control; Design Analysis; Aircraft Design

19990014360 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
RECONFIGURABLE FLIGHT CONTROL AT WRIGHT LABORATORY
Chandler, P. R., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 44-47; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Various government departments, including USAF Wright Laboratory, Naval Air Development Center, NASA, and ARPA are sponsoring the development of reconfigurable flight control systems. The reconfigurable system detects and compensates for in-flight failures and damage to maximize handling qualities and performance. Considerable success has been achieved to date. Some concepts have had limited flight tests, numerous piloted simulations have been performed on a range of aircraft, and lower risk portions of the technology have been transitioned to production A/C. The full benefit of reconfigurable flight control is just now being uncovered. Reconfigurable control is a subset of nonlinear or adaptive control. Compensating for large discrete events pays handsome benefits in survivability, fault tolerance, and safety of flight. Expansion of limited reconfiguration to a more fully adaptive approach pays even greater dividends. Such an approach will lead to faster development, reduced development costs, significantly less simulator tuning, a high degree of robustness to modeling errors and changes, and easy extensibility to new configurations and models. The technologies key to achieving these benefits are real-time parameter IDentification (ID), on-line control design, control allocation, and command limiting. Work to date has concentrated on Failure Detection, Isolation, and estimation (FDIE), and control power redistribution. These techniques generally involve extensive off-line development and are heavily model dependent. Due to the effort involved, the reconfiguration capability is limited. A full ID and on-line design approach is highly adaptive. However, the technology is not yet available to field a fully adaptive flight control system today with acceptable risk. In particular, the ID must be fast and accurate, identifying critical control and stability derivatives. The on-line control design must be highly nonlinear and accommodate a full range of hard limits, as well as be computable on-line. In addition, stability and robustness analysis of an adaptive system must be made to ensure the system can be flight certified. In the following sections, only the efforts sponsored at WL will be discussed.
Derived from text
Automatic Flight Control; Adaptive Control; Parameter Identification; Control Systems Design

09
RESEARCH AND SUPPORT FACILITIES (AIR)

19950025755 Esquimalt Defence Research Detachment, Victoria British Columbia, Canada
FACILITIES USED FOR PLASTIC MEDIA BLASTING
Foster, Terry, Esquimalt Defence Research Detachment, Canada; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 4 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

The equipment used for plastic media blasting (PMB) is generally independent of the media and is similar to equipment used in traditional abrasive blasting. PMB equipment is usually modified to enable the close control of the media flow and the operation at low pressures (30 - 40 psi). Because of the delicate nature of some of the stripping procedures, the nozzles used for PMB have been redesigned to improve cleaning rates, give an even distribution of particles and reduce the variation in particle velocity across the blast stream. This results in a more equal distribution of particles and impact energies at the substrate. There are three types of blast facilities available: blast cabinets for small components; blast booths which will accommodate larger components but may be used for purposes other than blasting, and blast rooms which are designed for complete vehicles or aircraft and are generally not used for other purposes.
Derived from text
Blast Loads; Cleaning; Compartments; Enclosures; Plastics

19950026081 Aeronautica Militare Italiana, Rome., United States
FIXED WING NIGHT ATTACK MISSIONS: ASSESSMENT IN A FLIGHT SIMULATION ENVIRONMENT
Arpaia, G., Aeronautica Militare Italiana, USA; Scarabotto, E., Aeronautica Militare Italiana, USA; Spinoni, I. M., Alenia Aeronautica, Italy; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 12 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Transforming a dedicated daytime attack aircraft in an effective night-attack weapon system requires the evaluation of different aircraft

and navigation/attack sensor configuration options. Flight Simulation has been considered an appropriate tool to enable preliminary evaluations of these different options. This paper illustrates the results of a first series of evaluations performed on the Alenia Aeronautica AM-X Flight Simulator with participation of Italian Air Force pilots and engineers to evaluate some proposed options for a night-attack version of the Alenia-Aermacchi-Embraer AM-X aircraft.
Derived from text
Attack Aircraft; Computer Systems Design; Computerized Simulation; Fixed Wings; Flight Simulation; Flight Simulators; Navigation Aids; Night Vision; Technology Assessment; Weapon Systems

19960024838 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
UTILIZATION OF 2.5D AND 3D CALCULATIONS OF UNSTABLE FLOW FOR SELECTING INSTRUMENTATION OF A TURBINE TEST STAND *UTILISATION DE CALCULS 2.5D ET 3D D'ECOULEMENTS INSTATIONNAIRES POUR LE CHOIX DE L'INSTRUMENTATION D'UN BANC D'ESSAI DE TURBINE*
Billonnet, G., Office National d'Etudes et de Recherches Aerospatiales, France; Fourmaux, A., Office National d'Etudes et de Recherches Aerospatiales, France; Huard, J., Office National d'Etudes et de Recherches Aerospatiales, France; Occhionigro, A., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Jan. 1996; 10p; In French; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

The equipment of a turbomachinery test rig is at once critical and the same time expensive as soon as that unsteady measurements are placed in rotating parts of the machine. A predicting numerical simulation can then provide to the research worker useful information concerning the number of pressure sensors and their locations. Then, the challenge consists of predicting 3D unsteady aspect of the flow in a turbine, by using a flow computation which take into account viscous effects due to boundary layers, wakes and rotor blade tip clearance. Such computation in a whole stage would require a great deal of computer memory and time. At the present time, this is not possible and only the computation in a reduced stage (one or two blades of each row) can be considered. This computation induces some approximations in the description of the unsteady flow phenomena. The objectives of this study are the following: - the validation of the 3D approach (in a reduced stage) with respect to the unsteady phenomena, by means of 2D calculations for which the calculated blade number ratio is very closed to the actual blade number ratio; - setting out the computations results of unsteady 3D viscous flow in a turbine stage; - showing how these results can help to the choice of the pressure sensors. This study is the first step of the code validation in the field of 3D viscous unsteady flows in turbomachinery.
Author
Blade Tips; Computational Fluid Dynamics; Test Stands; Turbomachinery; Unsteady Flow; Wakes; Three Dimensional Flow; Turbine Blades

19970000594 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
FLIGHT SIMULATION: WHERE ARE THE CHALLENGES? *SIMULATION DE VOL: QUELS SONT LES DEFIS?*
Apr. 1996; 398p; In English; In French; Flight Vehicle Integration Panel Symposium, 22-25 May 1995, Brunswick, Germany; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19970000595 through 19970000628
Report No.(s): AGARD-CP-577; ISBN 92-836-0024-X; Copyright Waived; Avail: CASI; A17, Hardcopy; A04, Microfiche

Effective Flight Simulation is an important capability for NATO nations, and it will become even more important in the face of reductions in defence budgets. This symposium reviewed the state of the art in flight simulation, in order to identify weaknesses where additional research and development are needed. Presentations dealt with simulation used for engineering and for training, both on the ground and in-flight. Session topics were: Visual and Motion Cueing and Requirements; Advances in Modelling; Simulation in Design and Development - Rotorcraft; Simulation in Design and Development - Fixed Wing and Systems; Simulation in Training; In-Flight Simulation; and Future Applications.
Author
Flight Simulation; Rotary Wing Aircraft; Research Projects; Training Simulators; Display Devices; Pilot Training; Visual Perception; Military Aircraft

19970000595 NASA Ames Research Center, Moffett Field, CA United States
HISTORICAL REVIEW OF PILOTED SIMULATION AT NASA AMES
Anderson, Seth B., NASA Ames Research Center, USA; Apr. 1996; 14p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper traces the conception and development of in-flight and ground based simulators at NASA Ames Research Center, starting in 1947 and continuing to the early 1990's. Problems with their development and operation and how limitations were handled are recounted. Advances needed in simulator equipment to improve performance and fidelity to gain pilot acceptance are discussed. The uses of these simulators in various aircraft research and development programs and their importance to aircraft design and flight testing are reviewed. Challenges remaining include a better understanding of the tradeoff between motion cues and visual cues, the importance of simulation sophistication when examining aircraft with marginal handling qualities characteristics, and the continuing need for upgrading simulation technology as more complex problems are encountered. Additional research is needed to understand the human behavior aspect in the pilot/simulator system.
Author
Histories; Research and Development; Visual Stimuli; Tradeoffs; Flight Simulators; Flight Simulation

19970000600 Technische Univ., SIMONA International Research Centre, Delft, Netherlands
ACHIEVING HIGH-FIDELITY MOTION CUES IN FLIGHT SIMULATION
Advani, S. K., Technische Univ., Netherlands; Mulder, J. A., Technische Univ., Netherlands; Apr. 1996; 12p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The simulation of high-bandwidth manual flight control tasks dictate the use of simulator motion systems for the reproduction of motion cues on the vestibular and neuromuscular-mechanical arm manipulator system. The reproduction of these cues, with particular emphasis on the lowest possible time delay, is necessary in human perception research, experimental flight control system development studies, as well as in routine flight training. Perfect reproduction of motion cues with ground-based flight simulators is principally impossible due to the kinematic limitations inherent to the motion system. Washout filters minimize these effects. The dynamic characteristics of the motion system however lead to two types of control errors: short-term, due to finite oil stiffness and line dynamics, as well as limited control valve bandwidth, and long-term, due to complexity of the non-linear motion system dynamics, making compensation of unwanted parasitic errors difficult. This paper will review techniques which increase the performance of six-degrees-of-freedom hydraulic motion systems for flight simulators. Application of pressure-feedback actuator control increases the robustness of the motion system dynamics, hence decreasing the short-term errors. The long-term control errors are addressed by a (separate) robust, multi-variable motion system controller which provides control signals to the platform with knowledge of the system state and its inherent properties. The total mass and the vertical location of the center of gravity of the platform influence the time delay (phase lag) and fidelity of the motion system. These properties also limit any such improvements due to design changes in software or hydraulic hardware. As a result of these studies, a fundamentally unique light-weight motion platform design is proposed, making extensive use of advanced composite materials. This is called the SIMONA Research Simulator. With the improvements made to motion cue quality, fundamental research into human

perception processes in human perception research, and experimental flight control system development work, will not be influenced by parasitic motions.
Author
Cues; Accuracy; Degrees of Freedom; Dynamic Characteristics; Flight Simulation; Flight Simulators; Motion Simulation; Motion Simulators; Robustness (Mathematics)

19970000603 Woodfield Aviation Research, Bedford, United Kingdom
SHIP AIRWAKES: A NEW GENERIC MODEL FOR PILOTED SIMULATION
Woodfield, Alan A., Woodfield Aviation Research, UK; Tomlinson, B. N., Defence Research Agency, UK; Apr. 1996; 18p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The disturbed airwake in the lee of the superstructure of ships with an aft flight deck causes significant control problems for helicopters operating during strong winds. Providing adequate data to describe these airwakes for use in night simulators has been a difficult task from either wind tunnel tests or theoretical airflow estimates. In this report an empirical mathematical model is developed based on the main types of airflow pattern present in airwakes. The model uses a single set of modelling parameters to produce airwake data for any shape of ship with an aft flight deck and for any wind direction. Assessment of the model in a piloted flight simulator has been very favorable with the main criticism being the absence of turbulence which is available in the model but could not be used because of difficulties in simulating helicopter responses at that time. Comparison of airwake estimates with a set of boundary layer wind tunnel results shows good agreement in the complex flow with the wind from starboard at 30 deg. and suggests some areas where adjustments to the model could improve the comparison for other wind directions. The model has highlighted several interesting features of airwakes, including probable improvements in airwakes if hangar tops can have porous net fences around the edges. the effects of gradients in vertical airflow velocities on control of a helicopter's height, and the need to include response to flow gradients in helicopter aerodynamic models for simulation of operations in airwakes. It is recommended that the airwake model should be validated against full scale and wind tunnel data on other shapes of ship, and, after any necessary adjustments to the model, it should be used for a trial installation on a suitable existing helicopter training flight simulator, prior to introduction into general use for R & D in helicopter/ship research programs and for helicopter training simulators.
Author
Wind Direction; Ships; Helicopters; Flight Simulators; Edges; Boundary Layers; Aerodynamic Characteristics; Air Flow

19970000604 Defence Research Agency, Flight Dynamics and Simulation Dept., Bedford, United Kingdom
A DYNAMIC CHALLENGE: HELICOPTER/SHIP INTERFACE SIMULATION: DEVELOPMENT, INTEGRATION AND APPLICATION
Tate, S. J., Defence Research Agency, UK; Apr. 1996; 16p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Piloted simulation has a potentially major role to play in training, test and evaluation and research in support of the helicopter/ship dynamic interface. The combination of visual/motion cueing and vehicle/environment modeling problems makes the helicopter/ship dynamic interface one of the most challenging in the simulation of aerospace vehicles. The exacting fidelity requirements of this application have hindered the use of simulation in this area until recently. This paper reviews the major fidelity issues of helicopter/ship interface simulation and describes some of the findings of a survey carried out of current simulators to attempt to identify areas that require improvement. The cost and operational benefits of the use of high fidelity piloted simulation in this field are outlined. Current Defense Research Agency (DRA) research work directed at improving models of the natural environment is described, as well as the thrust that future work will take. The uses of the high fidelity helicopter/ship dynamic interface simulation of the DRA Advanced Flight Simulator (AFS) in support of other research packages is described. This work covers the establishment of handling qualities criteria for maritime helicopters and the use of simulation to develop improved pilot visual cues for deck operations. Use of simulations has allowed rapid development at relatively low cost and at much reduced risk.
Author
Flight Simulation; Computerized Simulation; Visual Stimuli; Ships; Helicopters; Flight Simulators

19970000612 Alenia Aeronautica, Flight Simulation Center, Turin, Italy
TECHNOLOGICAL AND ECONOMICAL LIMITS EXPERIENCED FOR R/D MISSION SIMULATION
Castoldi, P., Alenia Aeronautica, Italy; Allocca, M., Alenia Aeronautica, Italy; LoPresti, S., Alenia Aeronautica, Italy; Trifoglietti, M., Alenia Aeronautica, Italy; Apr. 1996; 10p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper illustrates some significant lessons learned through R&D activities performed at the Flight Simulation Center of Alenia Aeronautica in Turin, highlighting experiences in Data Base Generation, Graphics and Graphics Prototyping, Particular Simulated Tasks and Integration of Dedicated Devices such as Target Projector and g-Seat g-Suit System. For each specific mission task, the problems, solutions, alternatives and resulting system limitations involved in identifying the required system characteristics are discussed.
Author
Research and Development; Flight Simulation; Flight Simulators; Computerized Simulation

19970000613 Dassault Aviation, Dept. Simulation Validation, Saint-Cloud, France
USE OF SIMULATION FOR DESIGN OF THE RAFALE NAVIGATION AND ARMAMENT SYSTEM *UTILISATION DE LA SIMULATION POUR LA CONCEPTION DU SNA DU RAFALE*
Goussault, R., Dassault Aviation, France; Leclere, M., Centre d'Essais en Vol, France; Apr. 1996; 8p; In French; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In this presentation conducted jointly by Dassault Aviation and the Flight Test Center (FTC), we first indicate important innovations introduced into the design of the Navigation and Armament System of Rafale Airplane and in particular the fundamental role of simulation. We subsequently show the synergy that exists between Dassault Aviation and the Flight Test Center and definition of the needs for this simulation, in the choice of models and equipment that comprise it and in its use by the industrial architect of the state. A few comments are necessary before entering into the heart of the matter: in the Rafale program, Dassault Aviation is the industrial architect of the Navigation and Armament System; the Flight Test Center is, within the General Administration for Armament, the expert state organization for flight tests as well as applications of aviation equipment and military onboard systems; and simulation here designates pilot simulation.
Author
Navigation; Aircraft Design; Computer Aided Design; Computerized Simulation

19970000614 Daimler-Benz Aerospace A.G., Dept. LME, Friedrichshafen, Germany
ARC SEGMENT ATTITUDE REFERENCE (ASAR): SIMULATOR APPLICATION DURING THE DEVELOPMENT PROCESS OF A NEW ATTITUDE REFERENCE SYMBOLOGY
Fuchs, W., Daimler-Benz Aerospace A.G., Germany; Fischer, G., Daimler-Benz Aerospace A.G., Germany; Flight Simulation: Where are the Challenges?; Apr. 1996; 6p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Pilots of modern fighter aircraft with high pitch and extremely high roll rates complain about fast moving and twisting pitch ladders on the head-up display (HUD) and the necessity to virtually concentrate their entire attention on the attitude references in order to maintain orientation in space when performing aggressive three-dimensional maneuvers. For this reason we were considering a more stationary flight attitude symbology to allow for attitude awareness, which requires less attention and concentration. The result was the introduction of the Arc Segment Attitude Reference (ASAR) Symbology. After a number of

alternating simulator trials and flight tests for further development and refinement of the symbology, a final version was agreed and already implemented in experimental programs.
Author
Attitude (Inclination); Head-Up Displays; Roll; Twisting; Pilots (Personnel); Flight Altitude

19970000615 British Aerospace Defence Ltd., Systems Engineering Research and Development, Preston, United Kingdom
ISSUES IN THE FLIGHT CLEARANCE OF VEHICLE MANAGEMENT SYSTEMS
Diston, D. J., British Aerospace Defence Ltd., UK; Weller, B. R. C., British Aerospace Defence Ltd., UK; Apr. 1996; 14p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The adoption ot highly-integrated and complex aircraft systems will facilitate the development of optimum strategies for vehicle management. This will provide benefits in functional performance and operational effectiveness. The drive towards standardization implies the adoption of some form of modular avionic architecture, thereby adding the benefits of improved logistics. In this paper, it is argued that these developments force a fundamental review of existing approaches to flight clearance. A number of challenges are proposed in the areas of Operating Systems, Analytical Control Theory and 'Virtual Rig' Simulation. In conclusion, the paper anticipates the evolution of a 'modular' procedure which might provide a legal basis for the certification of aircraft systems.
Author
Certification; Standardization; Management Systems; Clearances; Aircraft Design; Aircraft Industry

19970000616 National Aerospace Lab., Flight Simulation Dept., Amsterdam, Netherlands
THE DUTCH NATIONAL SIMULATION FACILITY: ADVANCEMENTS IN SIMULATOR TECHNOLOGY AND APPLICATION
Offerman, H. A. J. M., National Aerospace Lab., Netherlands; Apr. 1996; 10p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Dutch National Aerospace Laboratory NLR has developed during the last three years an advanced Full Mission Simulation capability for fast jet fixed wing and rotary wing aircraft. This Full Mission simulator, named the National Simulation Facility NSF, is created for research in training methodologies, investigation of simulation and simulator requirements for specific training tasks and to support industrial development of cockpit and aircraft systems. The current capability of the simulator focuses on the F-16 Mid-Life Update configuration, but will be extended to accommodate manned helicopter simulation later this year. The latter will be directed towards the recently (by the Dutch Air Mobile Brigade) procured Boeing CH-47D Chinook medium-heavy transport helicopter, and the McDonnell Douglas AH-64D Apache attack helicopter. This paper will address the various technical aspects of the National Simulation Facility.
Author
CH-47 Helicopter; Cockpits; F-16 Aircraft; Rotary Wing Aircraft; Flight Simulation; Flight Simulators

19970000617 Centre d'Essais en Vol, Section Etudes et Simulation, Istres, France
PILOTED MULTIPLE-TARGET SIMULATOR FOR DEVELOPMENT OF AIR-TO-AIR FIRE CONTROL *SIMULATEUR MULTICIBLE PILOTE POUR LE DEVELOPPEMENT DES CONDUITES DE TIR AIR/AIR*
Chevillot, J.-E., Centre d'Essais en Vol, France; Apr. 1996; 12p; In French; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Studies and Simulation Section of the Flight Test Center (Ministry of Defense) is participating closely in development of navigation and armament systems for all aircraft carrier programs (Rafale, Tigre, Mirage 2000, ...). The simulation tests of these navigation and armament systems require implementation of targets or teams that would comprise the tactical environment of the pilot. But as a function of the state of advancement of the investigations, the need varies from an automatic tactical environment to implementation of a team or of piloted targets for a greater level of realism.
Author
Fire Control; Target Simulators; Simulation

19970000620 National Research Council of Canada, Flight Research Lab., Ottawa, Ontario Canada
ASRA: A NEW TOOL FOR IN-FLIGHT SIMULATION. CURRENT STATUS AND ACTUATION STUDIES
Morgan, J. Murray, National Research Council of Canada, Canada; Baillie, Stewart W., National Research Council of Canada, Canada; Flight Simulation: Where are the Challenges?; Apr. 1996; 8p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Flight Research Laboratory (FRL) of the Institute for Aerospace Research (LXR) is in the process of developing an Advanced Systems Research Aircraft (ASRA) based on a Bell 412HP helicopter. This paper describes the current status of this facility, and discusses the approach being taken towards fly-by-wire actuation in this high control power host vehicle. The primary problem faced in designing a research fly-by-wire (FBW) actuation system for this aircraft is that of maintaining an adequate level of flight safety throughout the entire flight envelope, while limiting its simulation capabilities as little as possible, this is discussed. A scheme for compound actuation of the 'critical' axes is introduced. Initial off-line simulations of various failure modes are described and the results presented. The purpose of this paper is to present to the community a proposed approach to this problem and to describe some initial studies in support of the design concept used.
Author
Research Aircraft; Fly by Wire Control; Flight Simulation; Helicopters

19970000622 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik, Brunswick, Germany
ATTAS AND ATTHES IN-FLIGHT SIMULATORS
Buchholz, J. J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Bauschat, J.-M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Hahn, K.-U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Pausder, H. J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1996; 16p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper gives an overview of DLR's latest flight experiments, both with the fixed-wing in-flight simulator ATTAS and the helicopter in-flight simulator ATTHeS. After a detailed description of both testbeds and the corresponding ground based simulators, flight test results are presented. These include experiments on in-flight simulation, rate saturation, reconfiguration, flight control laws, handling qualities, and vision based hovering. The paper concludes with a discussion on certain aspects of simulation fidelity.
Author
Flight Control; Control Theory; Flight Simulation; Flight Simulators; In-Flight Monitoring

19970000624 Thomson Training and Simulation Ltd., Clergy Pontoise, France
EXPERIENCE ACQUIRED DURING IMPLEMENTATION OF INTERACTIVE DISTRIBUTED SIMULATION PROTOCOLS WITH ALREADY EXISTING SIMULATIONS *EXPERIENCES ACQUISES LORS DE LA MISE EN OEUVRE DES PROTOCOLES SID AVEC DES SIMULATIONS DEJA EXISTANTES*
CrassousdeMedeuil, Claude, Thomson Training and Simulation Ltd., France; Apr. 1996; 10p; In French; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The need to combine simulators or simulations grows each day, and the diversity of these simulations is very great. Past experiments have demonstrated that it is nearly impossible to interconnect pre-existing simulations when necessary for this purpose to use common methods and structures that are imposed for all simulations. The availability of Interactive Distributed Simulations (SID) allows one to combine heterogeneous simulations without having to modify them in an important way. In addition, current simulators have certain partic-

ular features when one compares them to recent simulators. They are often limited in memory, calculation power, and only rarely have means to connect to communication networks.
Author
Flight Simulation; Computerized Simulation

19970000625 Naval Air Warfare Center, Flight Vehicle Simulation Branch, Patuxent River, MD United States
HIGH FIDELITY, MOBILE, NET WORKABLE TRAINERS: THE TRAINERS OF THE FUTURE?
Miller, Chad C., Naval Air Warfare Center, USA; Perdue, David, Naval Air Warfare Center, USA; Davis, Scott, Naval Air Warfare Center, USA; Apr. 1996; 8p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The U.S. Naval Air Warfare Center Aircraft Division Patuxent River personnel recently completed a high fidelity, low cost mobile prototype AH-1W Aircrew Procedures Trainer for the USA Marine Corps at Camp Pendleton, California. The use of recent technological breakthroughs in both super-micro computers and visual display technologies made this program possible. These breakthroughs pave the way for future OFT/APT developments. The AH-1W APT project demonstrated the application of evolving simulation technology in four areas. First, that new technologies reduce the physical size of room required to support computational requirements of WSTs. Second, newer technologically advanced COTS computers can be used in a rugged environment without any special expensive considerations. Third, existing full-size training systems could be supplemented or replaced by such small, mobile devices such as the AH-1W high fidelity trainer prototype constructed at NAWC AD. Fourth, fixed wing tactical aircraft training systems that do not require motion cueing devices are particularly attractive for this application.
Author
Flight Simulation; Training Devices; Flight Training; Display Devices; Computers; Aircraft Configurations

19970000626 Science Applications International Corp., McLean, VA United States
SIMULATION, DISTRIBUTED SIMULATION, AND SYNTHETIC ENVIRONMENTS. FUTURE APPLICATIONS AND CHALLENGES
Adolph, Charles E., Science Applications International Corp., USA; Thorpe, Jack, Science Applications International Corp., USA; Apr. 1996; 10p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This survey paper reviews current practices in simulation technology with emphasis on aircraft development and testing, followed by a discussion of present and future applications of distributed simulation and synthetic environments. The aviation community has used a wide variety of simulation tools for over 35 years. The benefits of current generation standalone simulation tools, including system integration laboratories, are well understood. Distributed simulation is beginning to be used to support training and requirements definition; test applications are also beginning to be explored. Advanced distributed simulation provides an unprecedented opportunity to explore new concepts as well as improve the efficiency of test and training activities.With the rapid increases in information processing technology, synthetic environments will be used increasingly to support test and training, both in standalone and interactive distributed modes. There are numerous challenges in developing and applying these technologies; including simulation fidelity and scalability, verification and validation. There is also a need to decrease simulation costs. The emergence of distributed simulation has been the catalyst for increased interaction between the simulation world and test and training systems. Next generation range and platform instrumentation architectures will be designed to facilitate interaction between live players and simulated entities.
Author
Flight Simulation; Computerized Simulation; Systems Integration; Systems Simulation; Procedures

19970000627 British Aerospace Defence Ltd., Military Aircraft Div., Warton, United Kingdom
THE SYNTHETIC ENVIRONMENT: THE ULTIMATE DEFENCE SIMULATION?
Beckett, Peter, British Aerospace Defence Ltd., UK; Apr. 1996; 6p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

References to 'Defence Synthetic Environments' are becoming more common with the passage of time. At present, the term means different things to different people driven largely by their viewpoint within the defence business. Indeed, to confine the concept to the defence business is already narrowing the vision according to some. There are envisaged opportunities for applying similar techniques in commerce, medicine, transport and so on. In fact any large system is a potential candidate. The defence business was, however, probably the first to adopt the name and to start demonstrating what it means. In the UK, joint government and industry groups have been established to steer national activities for SE's. A number of early demonstrators are underway. In the USA, regular networking demonstrations illustrate how this particular component of SE is maturing. The general impression is one of commitment to SE as a long term goal. The intention of this paper is to give a view of the extent of Synthetic Environments (SE) and to discuss how it may be put together and used to help the defence business. In doing this the role of Flight Simulation within SE is highlighted along with the challenges which it faces. The need for improvements throughout the defence business hardly needs justification here. Pressures created by falling defence budgets, uncertain threats, shorter development times and heavy competition all point to the need for process improvements right across the board. to embrace the opportunities offered by SE requires changes in all the parties involved including the customer. The resulting increase in effectiveness and level of concurrency between all the stakeholders should be a worthwhile payback.
Author
Industries; Growth; Military Technology; Military Operations; Simulation

19970012411 Armstrong Lab., Crew Technology Div., Brooks AFB, TX United States
ADVANCED SPATIAL DISORIENTATION DEMONSTRATOR: COMPONENT, PROFILE, AND TRAINING EVALUATION
Yauch, D. W., Armstrong Lab., USA; Ercoline, W. R., Krug Life Sciences, Inc., USA; Previc, F. H., Armstrong Lab., USA; Holoviak, S. J., School of Aerospace Medicine, USA; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Results of the first experimental evaluation of the Advanced Spatial Disorientation Demonstrator (ASDD) installed at Brooks AFB, TX are described. The ASDD was evaluated by a mix of experienced pilots and novices. Spatial Disorientation (SD) training profiles were programmed into the device in an attempt to induce Type 1 (unrecognized) and Type 2 (recognized) SD. Reliable generation of SD illusions and visual/vestibular sensory conflicts on the ground, in a safe environment, can m principle provide training to aircrew to aid in recognizing and coping with SD in flight, and also can be used as an environment to design instrument displays. to that end, the ASDD components, SD profiles, and training potential were evaluated.
Author
Training Evaluation; Display Devices; Aircraft Pilots; Disorientation

19970012414 Environmental Tectonics Corp., Southampton, PA United States
REVIEW OF MOTION-BASED PHYSIOLOGICAL TRAINING DEVICES
Mitchell, William F., Environmental Tectonics Corp., USA; Leland, Richard A., Environmental Tectonics Corp., USA; Selection and Training Advances in Aviation; Nov. 1996; 16p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The use of motion based training devices permeates all of Aerospace Physiology training and continues to grow in sophistication. Motion based training devices present the opportunity for truly interactive training. However, for such devices to be completely effective, they must possess the qualities of low acquisition and operating cost, multiple task training capability, flexibility of use, and high fidelity, and they must be interactive. Future development of motion based training devices for physiological training should be a start-to-finish joint effort between customer/user groups, research centers of excellence and industry as a cooperating triad.
Derived from text
Training Devices; Physiology

19970012415 School of Aerospace Medicine, Dept. of Aerospace Physiology, Brooks AFB, TX United States
THE USAF ADVANCED SPATIAL DISORIENTATION DEMONSTRATOR PROGRAM
Holoviak, S. J., School of Aerospace Medicine, USA; Yauch, D. W., Armstrong Lab., USA; Ercoline, W. R., Krug Life Sciences, Inc., USA; Selection and Training Advances in Aviation; Nov. 1996; 8p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The search for ground-based devices that can generate realistic motion and forces of an aircraft in flight is ongoing. However, with the maturing of several technologies, mostly in the computer and visual arenas, the Advanced Spatial Disorientation Demonstrator (ASDD) has surfaced as the prime United States Air Force (USAF) candidate. It combines these new technologies to generate repeatable and sustainable flight-like forces with unsurpassed fidelity. The device, though still in its infancy, has proven that realistic spatial disorientation (SD) illusions can be generated in a save, ground-based environment. This program overview highlights the ASDD's capabilities, which will have a drarmatic impact on the way pilots will receive SD familiarization training for the next decade.
Author
Disorientation; Training Simulators

19970012416 Institute of Aviation Medicine, Div. 3, Fuerstenfeldbruck, Germany
THE FLIGHT ORIENTATION TRAINER AS A DUAL PURPOSE DEVICE: TRAINING VERSUS AEROMEDICAL RESEARCH
Lichtschlager, A., Institute of Aviation Medicine, Germany; Scherb, W. H., Institute of Aviation Medicine, Germany; Heinz, G., Institute of Aviation Medicine, Germany; Pongratz, H., Institute of Aviation Medicine, Germany; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

German Air Force acquired the 'Flight Orientation Trainer (FOT)' and installed it in the facilities of the German Air Force Institute of Aviation Medicine (GAF IAM) in Furstenfeldbruck to improve its training efforts in aviation physiology and especially in spatial disorientation In 1994 a troop trial was conducted to have the FOT tested and evaluated by experienced pilots of the German Armed Forces. Results of the troop trial are described and the best timing for training in the FOT is discussed. The evaluation and validation of the FOT requires calibration and counter-measure equipment to cover various aspects of spatial orientation, situation awareness and motion sickness. The relevance of pilot's ability to react under changing orientation can be shown in a orthostatic stress test on tilt-table. An individual susceptibility for syncopal reaction can lead to loss of awareness and motion sickness.
Author
Training Devices; Motion Sickness; Disorientation; Aircraft Pilots; Aerospace Medicine

19970015688 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
PILOTED SIMULATION IN LOW ALTITUDE, HIGH SPEED MISSION TRAINING AND REHEARSAL *LA SIMULATION PILOTEE POUR L'ENTRAINEMENT ET LA PREPARATION DES MISSIONS A BASSE ALTITUDE ET A GRANDE VITESSE*
Mar. 1997; 116p; In English
Report No.(s): AGARD-AR-333; ISBN 92-836-1050-4; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

The subject of low altitude flying training has received increased attention in recent years for political and technical reasons, including cost, environmental impact and the expanding training requirements of modem airborne weapon systems. Conducting low-level flying training 'live' is becoming less and less acceptable in many NATO nations, while the threat continues to demand even lower altitudes at higher speeds. Restrictions on low flying training exist in many countries, and include reduced low flying time, speed restrictions, and altitudes restricted to no lower than 1000 ft. Following the AASC studies on 'Low Level Flight Training' and 'Reduction of the Environmental Impact of Operational Flying Training'. Working Group 20 was established by the AGARD Flight Mechanics Panel (now the Flight Vehicle Integration Panel) to build on their conclusions and to examine the current capability and future potential of simulation technology in low altitude high speed mission training and rehearsal. It held its first meeting in October 1991. In conducting its review, the Working Group examined some relevant mission simulators in several NATO countries: the UK Harrier GR Mk5/7 mission simulator, the German Tornado Low-Level Test Bed simulator, and the US Apache helicopter Combat Mission Simulator.
Author (revised)
Flight Training; Systems Simulation; Flight Simulation; Combat; Flight Mechanics; Low Altitude

19970016374 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
ADVANCES IN CRYOGENIC WIND TUNNEL TECHNOLOGY *LES AVANCEES EN TECHNOLOGIE DES SOUFFLERIES CRYOGENIQUES*
Special Course on Advances in Cryogenic Wind Tunnel Technology; Feb. 1997; 276p; In English, 20-24 May 1996, Koln, Germany; See also 19970016375 through 19970016390
Report No.(s): AGARD-R-812; ISBN 92-836-1047-4; Copyright Waived; Avail: CASI; A13, Hardcopy; A03, Microfiche

The development and use of cryogenic wind tunnels represents a major advance in aerodynamics testing. One advantage of cryogenic tunnels is their ability to achieve full-scale values of Reynolds number in tunnels of moderate size at reasonable operating pressures. Another important advantage is the ability to independently vary temperature, pressure and speed, which lets one separate the effects of Reynolds number, aeroelasticity and Mach number. This series of lectures, supported by the AGARD Fluid Dynamics Panel and the von Karman Institute, incorporated a brief review of the development and early uses of cryogenic tunnels, and reports on current operational cryogenic facilities. It then covered the theory and advantages of cryogenic wind tunnels, as well as the special considerations required in their design, construction, and use. Subjects included cryogenic systems, thermal insulation, facility and model design and construction, strain-gage balances, pressure instrumentation, flow visualization, data accuracy, safety, and productivity.
Author
Cryogenic Wind Tunnels; Aerodynamics; Aeroelasticity; Flow Visualization; Boundary Layer Control; Hypersonic Flight; Laminar Flow; Incompressible Flow; Viscous Flow; Turbulent Flow

19970016375 Southampton Univ., Dept. of Aeronautics and Astronautics, United Kingdom
INTRODUCTION TO CRYOGENIC WIND TUNNELS
Goodyer, M. J., Southampton Univ., UK; Special Course on Advances in Cryogenic Wind Tunnel Technology; Feb. 1997; 14p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The situation which existed in the era which spawned the cryogenic wind tunnel, the early 1970's, is first explained. The background includes the strong desire felt at that stage to raise Reynolds number in transonic testing, together with the response in the form of the expensive solutions then under consideration. Some paper studies describing the benefits of changing test temperature did exist, mostly older and obscure, but had been ignored up to this time. This situation coincided with the contemporary state of maturity of cryogenic engineering. The cryogenic wind tunnel evolved in this environment as the way to increase Reynolds number while avoiding undue increase of wind tunnel size or operating pressure. The paper describes the theoretical principles, showing the way in which it achieves its aim. Some cryogenic wind tunne practice is included. also a description of beneficial feature additional to achieving high test Reynolds numbers. These are a rather important reduction of motor power in the case of fan-driven tunnels and the ability for the first time in wind tunnel testing to isolate the separate effects of change in Reynolds number, Mach number and dynamic pressure. Finally there is an outline of the way in which cryogenic operation affects some representative types of tunnel.
Derived from text
Cryogenic Wind Tunnels; Mach Number; Dynamic Pressure; High Reynolds Number

19970016377 Cryogenic, Marine and Materials Consultants, Southampton, United Kingdom
MATERIALS FOR USE IN CRYOGENIC WIND TUNNELS
Wigley, David A., Cryogenic, Marine and Materials Consultants, UK; Special Course on Advances in Cryogenic Wind Tunnel Technology;

Feb. 1997; 18p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The basic concepts of yield, plastic deformation, toughness and crack propagation are discussed in the context of those alloys likely to be used in cryogenic wind tunnels. The mechanical and physical properties of the major alloys used for model construction are discussed and summarized. Dimensional instability in 15-5PH and 17-4PH stainless steels makes them unsuitable for use, but 304L, A286, Nitronic 40 and PH13-8Mo have been used successfully. 200 grade 18 nickel maraging steel has been extensively used for constructing models and stings, but for large diameter forged bars the Charpy impact energy, Cv, at 77K falls well below the required value of 34 J. An empirical relationship between bar diameter and C(sub v) at 77K is demonstrated for samples cut in the AR, RR and RA orientations, the orientation effect being most marked between diameters of 150 and 400 mm. The use of 250 grade 18 Ni maraging steel and beryllium copper for balances is also considered. Fabrication techniques are discussed with particular reference to the dimensional changes induced by different machining operations and the implications for the fabrication of high-accuracy components. Non-conventional machining methods and various joining techniques are also discussed. The availability of information in a form suitable for use in model design and stress calculations is discussed in the light of the recent publication of the ETW Materials Guide and the data compilations in its appendices.
Derived from text
Cryogenic Wind Tunnels; Yield Strength; Plastic Properties; Toughness; Crack Propagation; Plastic Deformation

19970016378 Vigyan Research Associates, Inc., Hampton, VA United States
CRYOGENIC MODEL SYSTEMS
Young, Clarence P., Jr., Vigyan Research Associates, Inc., USA; Feb. 1997; 28p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This lecture presents current information on cryogenic model design requirements, developmental model design studies, design and fabrication experience, recent surface finish and pressure orifice studies, and current practices for filler materials and fastener applications. In addition, results of advanced model support system studies are presented along with composite model designs for cryogenic application, and information relating to cost factors for cryogenic models versus conventional models. Finally, some future development needs are suggested for cryogenic model systems.
Derived from text
Cryogenics; Design Analysis; Fabrication; Support Systems; Models

19970016379 Office National d'Etudes et de Recherches Aeronautiques, Paris, France
INSTRUMENTATION FOR CRYOGENIC TUNNELS
Bazin, M., Office National d'Etudes et de Recherches Aeronautiques, France; Blanchet, C., Bertin et Cie, France; Dupriez, F., Institut de Mecanique des Fluides de Lille, France; Feb. 1997; 20p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A few examples are given of recent work on the European Wind Tunnel (EWT): the sting balance, which is insensitive to temperature and to the thermal gradients; qualification of the transition Reynolds number in the flow; determination in the transition position on models (coating, artificial triggering, and low-temperature infrared camera); optical measurement of the model attitude; and design and construction of a civil aircraft model.
Author
Wind Tunnels; Aircraft Models; Temperature Gradients; Reynolds Number

19970016380 Technische Univ., Griesheim windkanal, Darmstadt, Germany
FORCE TESTING WITH INTERNAL STRAIN GAGE BALANCES
Hufnagel, Klaus, Technische Univ., Germany; Ewald, Bernd, Technische Univ., Germany; Feb. 1997; 18p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The ever rising accuracy requirements in wind tunnel testing for airplane development enforce continuous improvement of force testing technology. The introduction of the cryogenic tunnel is an additional challenge for the force balance since now the balance accuracy is requested over an operational temperature range of 200 Kelvin. More than I5 years ago several teams in the world therefore started with investigations in the area of internal balances for cryogenic wind tunnels. In Germany in 1979 the 'Cryogenic Balance Program' was started by the German Ministry for Research and Technology with the target to develop internal balances and calibration technique for the planned cryogenic wind tunnels KKK and ETW. In the past 17 years of research all aspects of force testing technology have been dealt with and developed to new standards by the Technical University of Darmstadt together with Deutsche Aerospace Airbus GmbH, Bremen. Within this period 8 balances for cryogenic wind tunnels were built. Basic research on the aspects of metallic spring materials resulted in new understandings about material selection and material treatment for optimum results. Principle balance design optimizations are done with finite element analysis. For the routine balance design an interactive computer program was created. The very successful technique of the Electron Beam Welded Balance was developed The balance structure is fabricated from parts, which are welded together by electron beam welding. This technigue makes it possible to build balances with a complex inner structure to minimize the interferences. For cryogenic balances the main problems are zero shift and sensitivity shift over the large temperature range and false signals especially in the axial force element due to temperature gradients. The problems were overcome by a very careful strain gage matching process by use of special gages by application of numerical corrections and by a special design of the axial force system with tandem measuring elements in the flexure groups.
Derived from text
Force Distribution; Strain Gage Balances; Cryogenic Wind Tunnels; Design Analysis; Calibrating; Accuracy; Fabrication

19970016381 Centre d'Etudes et de Recherches, Toulouse, France
FUNDAMENTAL CONSIDERATIONS FOR TESTING IN CRYOGENIC TUNNELS
Mignosi, Andre, Centre d'Etudes et de Recherches, France; Feb. 1997; 16p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper summarizes a number of aerodynamic phenomena mainly related to cryogenic pressurized testing. The goal of the analysis effort has been to address aerodynamic difficulties associated with the severe environment of this cryogenic wind tunnel. The first part describes some of the various flow parameters important to respect the achievement of the best similarity between an aircraft in flight and the model in the wind tunnel. The second part covers the different effects of these factors from simple 2D cases to complex 3D flows: effects of the Reynolds number on laminar and turbulent flows, boundary layer transition, influence of non adiabatic model wall. Theoretical and experimental points of view are presented and illustrated with practical examples. Efforts to obtain reliable and accurate results have been done in the past and need to be continued to provide the scientists and manufacturers which results leading to a better optimization and prediction of the aircraft performances.
Derived from text
Wind Tunnel Models; Aerodynamic Characteristics; Cryogenic Wind Tunnels; Flow Characteristics

19970016382 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fur Stromungsmechanik, Brunswick, Germany
THE CRYOGENIC LUDWIEG-TUBE TUNNEL AT GOTTINGEN
Rosemann, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Feb. 1997; 14p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Cryogenic Ludwieg-Tube of DLR at Gottingen (KRG) is a blow-down wind tunnel designed for high Reynolds number research in transonic fow. Temperatures down to 100 K and stagnation pressures up to 1 MPa are applied to achieve Reynolds numbers of up to 60 x 10(exp 6) (2-D) based on a model chord ol I50 mm. In 1994, a new test section with 2-D adaptive walls was installed after the performance of the KRG had been evaluated with a relatively simple slotted wall test section. This paper gives an overview over the Ludwieg-Tube concept and describes the design and operation of the facility as well as the main components with special emphasis on the new 2-D adaptive wall test section and the adaptation method. Two techniques to determine transition under cryogenic conditions have been tested and

will be presented. Finally, results ot the calibration program and some comparative airfoil testing including a Reynolds number study on a laminar-type airfoil will be shown.
Derived from text
Cryogenic Wind Tunnels; Test Chambers; High Reynolds Number; Transonic Flow; Walls

19970016383 Centre d'Etudes et de Recherches, Dept. of Aerothermodynamics, Toulouse, France
T2 TRANSONIC CRYOGENIC WIND TUNNEL AT TOULOUSE
Seraudie, Alain, Centre d'Etudes et de Recherches, France; Archambaud, Jean Pierre, Centre d'Etudes et de Recherches, France; Feb. 1997; 14p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

T2 is an induction driven wind tunnel in which Reynolds number variations are obtained by increasing the total pressure (P(sub t)) = 1,4 to 3 bar) and reducing the total temperature (T(sub t) = 300 to 110 K). The flow is driven by an injection of dry air at ambient temperature and cooled by another injection of liquid nitrogen. This paper presents the evolution of T2 wind tunnel, mainly in cryogenic condition since 1981, and the aerodynamic cryogenic developments we performed around the wind tunnel activity. Firstly it gives the wind tunnel main characteristics, it describes the flow control system, and the hollow model technique developed for cryogenic runs. The flow quality measurements are presented, with pressure, temperature, and mass flow fluctuation levels. Moisture contamination is a great problem for flow quality, and we present some solutions to perform good tests on laminar models at high Reynolds numbers. Finally this paper presents some typical results obtained in cryogenic condition: velocity measurements with a laser Doppler anemometer, transition qualification at variable Reynolds number and buffeting investigation with unsteady measurements.
Author
Cryogenic Wind Tunnels; Transonic Wind Tunnels; Reynolds Number

19970016384 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Pulheim, Kryo Kanal Koln, Cologne, Germany
THE CONCEPT OF THE KRYO-KANAL-KOLN (KKK) OPERATIONAL EXPERIENCE, FLOW QUALITY, MODEL HANDLING AND HALF MODEL TESTING TECHNIQUE
Viehweger, G., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Special Course on Advances in Cryogenic Wind Tunnel Technology; Feb. 1997; 10p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The aerodynamic calibration of the KKK at ambient and cryogenic temperatures was completed in 1989. In parallel the control system of the tunnel, which is constructed in a modular basis, was modified and improved to save liquid nitrogen consumption. During this time operating problems in the circuit and in the subsystems resulting from the cryogenic mode of operation were identified and solved. Basic tests were performed to understand the physics of the desorption of moisture from the internal insulation into the circuit which resulted in a special purging procedure before cryogenic operation. The aerodynamic tests demonstrated the high flow quality in the test section in the whole operation range. This paper will give a review on the experimental experience and describes the test equipment of the tunnel.
Derived from text
Cryogenic Wind Tunnels; Calibrating; Test Chambers; Revisions

19970016385 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne, Germany
DEVELOPMENT OF CORRECTION PROCEDURE FOR SIGNALS OF CRYOGENIC BALANCES
Rebstock, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Feb. 1997; 12p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Requirements in accuracy and repeatability of test results given by aircraft industry are increasing more and more. Therefore, it is essential to recognize in time all influence on cryogenic balances like model weight and geometric and influence of moisture and temperature gradients top be able to lake corrections with suitable procedures. A special attention is payed on diffusion of moisture into carrier material of the strain gauges, which into be avoided by convenient coatings.
Derived from text
Correction; Procedures; Cryogenics; Balance

19970016386 Vigyan Research Associates, Inc., Hampton, VA United States
MODEL DYNAMICS
Young, Clarence P., Jr., Vigyan Research Associates, Inc., USA; Feb. 1997; 28p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Model dynamics is a continuing problem when testing in high Reynolds number, high pressure, cryogenic wind tunnels. This lecture describes model and model support vibration problems that have been encountered in the National Transonic Facility located at the NASA Langley Research Center. Test experience and studies related to identification of excitation sources, attenuation of model vibrations, and changes in structural damping at cryogenic temperatures are presented. Results of a successful buffet test conducted in the National Transonic Facility are discussed along with studies of the effects of model vibration on inertial wind-tunnel model attitude measurement devices. Finally, online model systems dynamics monitoring systems currently being used in the National Transonic Facility are described.
Derived from text
Dynamic Models; High Reynolds Number; High Pressure; Cryogenic Wind Tunnels; Vibration Effects; Dynamic Structural Analysis

19970016387 ETW G.m.b.H., Cologne, Germany
AN OVERVIEW OF TEST CAPABILITIES AT ETW
Price, Ian, ETW G.m.b.H., Germany; Schimanski, Dieter, ETW G.m.b.H., Germany; Feb. 1997; 12p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Throughout the project stages, from the planning and design phases through to the present initial operations phase, it has always been recognized that technical excellence and productivity were fundamental to the success ot ETW. In a fiercely competitive market technical excellence must be consistent with state of the art transonic testing especially at high Reynolds numbers. Test techniques have therefore been developed to achieve the high productivity levels required by industrial users for efficient testing. This paper reviews the major features of the test techniques developed which aim at achieving a high technical quality of testing and a high productivity. Special attention has been paid to ensure that the design for high productivity, has not compromised the technical quality of the final data output.
Derived from text
Test Facilities; Project Planning; Productivity

19970016388 ETW G.m.b.H., Cologne, Germany
CRYOGENIC INTERNAL BALANCE CALIBRATION AT ETW
Badet, L. M., ETW G.m.b.H., Germany; Feb. 1997; 16p; In English; See also 19970016374; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The ETW is a closed circuit, continuous flow transonic windtunnel operating with gaseous nitrogen over a temperature range of 90 K to 313 K and up to 4.5 bar absolute total pressure. For correct simulation of real flight conditions of an aircraft in a windtunnel, the most advanced measurement techniques have to be applied. One important measuring tool is the 'Internal Strain Gauge Balance'. The Internal Balance (IB), dynamometric transducer, for a full span aircraft model is mounted between the model and the model support sting. These balances are required to measure, to the highest degree of accuracy, the aerodynamic loads acting on a model during windtunnel testing, whilst operating in the test section in conditions defined as above. to achieve high accuracies for model load measurements, the basic performance of the balances under all operating conditions and the precision of the balance calibration process prior to the test in the wind tunnel, are of fundamental importance. The aerodynamic loads acting on the model aerodynamic center during the test are represented by a vector force and a vector moment. These are both split on a reference axis system attached to the above mentioned center, into six

aerodynamic components; three forces and three moments. In order to give a comprehensive aerodynamic analysis of a model under wind, the measuring instrument Internal Balance must be able to measure each of these six degrees of freedom.
Derived from text
Cryogenic Wind Tunnels; Calibrating; Balance; Strain Gage Balances; Aerodynamic Balance; Aerodynamic Characteristics; Aerodynamic Loads; Accuracy

19970016389 NASA Langley Research Center, Hampton, VA United States
THE NATIONAL TRANSONIC FACILITY (NTF) OPERATIONAL STATUS
Hill, Jeffrey S., NASA Langley Research Center, USA; Feb. 1997; 18p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The National Transonic Facility (NTF) is a fully operational, productive and efficient cryogenic wind tunnel currently supporting the Nation's aircraft industry needs providing flight Reynolds number research data for focused development programs as well as investigating the Reynolds number scaling phenomenon. The following presentation is a collection of viewgraphs and notes prepared from previous talks. This material is intended to provide a 'general overview' of The National Transonic Facility (NTF) Operational Status as outlined in the following Agenda.
Derived from text
Transonic Wind Tunnels; Cryogenic Wind Tunnels; Reynolds Number; General Overviews

19970016390 NASA Langley Research Center, Hampton, VA United States
OTHER CRYOGENIC WIND TUNNEL PROJECTS
Kilgore, Robert A., NASA Langley Research Center, USA; Feb. 1997; 8p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The first cryogenic tunnel was built at the NASA Langley Research Center in 1972. Since then, many cryogenic wind-tunnels have been built at aeronautical research centers around the world. In this lecture some of the more interesting and significant of these projects that have not been covered by other lecturers at this Special Course are described. In this lecture authors describe cryogenic wind-tunnel projects at research centers in four countries: China (Chinese Aeronautical Research and Development Center); England (College of Aeronautics at Cranfield, and Defence Research Agency - Bedford); Japan (National Aerospace Laboratory, University of Tsukuba, and National Defense Academy); and United States (Douglas Aircraft Co., University of Illinois at Urbana-Champaign, and NASA Langley).
Derived from text
Cryogenic Wind Tunnels; Wind Tunnel Tests; Advanced Technology Laboratory

19970029162 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
AERODYNAMICS OF WIND TUNNEL CIRCUITS AND THEIR COMPONENTS *L'AERODYNAMIQUE DES CIRCUITS DES SOUFFLERIES ET DE LEURS COMPOSANTS*
Aerodynamics of Wind Tunnel Circuits and their Components; Jun. 1997; 446p; In English; 79th; Fluid Dynamics Panel Symposium, 30 Sep. - 3 Oct. 1996, Moscow, Russia; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19970029163 through 19970029194
Report No.(s): AGARD-CP-585; ISBN 92-836-0042-8; Copyright Waived; Avail: CASI; A19, Hardcopy; A04, Microfiche

The aim of this Symposium was to gather and review both current knowledge and ongoing research on the aerodynamic design and evaluation of ground test facilities, focusing primarily on wind tunnels, in order to provide to the designers of experimental facilities an opportunity to exchange information, ideas, and visions. Shrinking budgets for new facilities have led to fewer facilities being developed and longer development times, which have in turn led to less opportunity for advances in the state-of-the-art and for the retention of the experts needed for the design of good experimental facilities. The normal overriding user objectives, when conducting almost any kind of wind-tunnel test, are obtaining reliable and meaningful data in a timely and cost-effective manner. Principal requirements for obtaining reliable and meaningful data are an adequate Reynolds number, representative or satisfactory tunnel flow quality, and the avoidance of tunnel wall and support system effects. Factors which are important in satisfying the timeliness and cost effectiveness requirements include minimizing the time required for model installation and configuration changes, utilization of efficient data gathering systems, and the ability to use rapid techniques to account for tunnel wall and support system interference effects. Since the aerodynamic design of wind-tunnel circuits has a fundamental first order effect on tunnel flow quality, tunnel wall and support interference effects, and on tunnel construction costs, the adequacy of the circuit design is of crucial importance in meeting the user's objectives. It should be noted that this was the first AGARD Symposium held in Russia, and that 50% of the papers were by Russian authors. Much information was shared by those who are involved in developing, operating, and utilizing experimental ground test facilities.
Author
Aerodynamic Interference; Circuits; Wind Tunnel Tests; Support Systems; Support Interference; Reynolds Number

19970029163 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia
HISTORIC REVIEW OF THE CREATION AND IMPROVEMENT OF AERODYNAMIC TEST FACILITIES AT TSAGI
Bedrzhitsky, E. I., Tsentralni Aerogidrodinamicheskii Inst., Russia; Roukavets, V. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Jun. 1997; 12p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A team of young scholars, engineers and pilots possessing already a practical experience of researches in the area of aerohydrodynamics at the Computation and Research Bureau (CRB) established within the Moscow High Technical College (Moskovskoe Vysshee Tehnicheskoe Uchilishe MVTU) in 1916 formed the kernel of TsAGI headed by N.E. Zhukovsk . The foundation for these researches was laid by a methodology created by N.E Zhukovsky and consisting in a continuous combination of fundamental, searched-for and applied researches with experimental investigations in the wind tunnels. This principle was preserved and developed through all stages of activities of TsAGI where the problems of creation of the experimental aerodynamic equipment and development of the scientifically grounded test methodology had always been of primary emphasis.
Derived from text
Aerodynamic Characteristics; Computation; Hydrodynamics; Wind Tunnel Tests

19970029164 McDonnell-Douglas Corp., Long Beach, CA United States
SOME CONSTRAINTS IMPOSED ON THE AERODYNAMIC DEVELOPMENT PROCESS BY WIND-TUNNEL CIRCUIT DESIGN CHARACTERISTICS
Lynch, F. T., McDonnell-Douglas Corp., USA; Crites, R. C., McDonnell-Douglas Corp., USA; Jun. 1997; 12p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Requirements for obtaining reliable and meaningful data in most wind tunnel test situations are addressed from an aircraft industry user's perspective. Factors considered are Reynolds number requirements, tunnel flow quality requirements, and tunnel wall and support system effects. Factors which are important in satisfying timeliness and cost effectiveness requirements are also identified. Important flow quality imperfections which exist with less-than-perfect wind-tunnel circuit aerodynamic design are considered, together with a review of the existing knowledge base for assessing the likely/potential effects of variations in these imperfections on the resultant test data. The need to have a thorough knowledge of the important flow physics features which are controlling the aerodynamic, aeroacoustic, and/or propulsion characteristics of the vehicle or flow situation under investigation at the associated test conditions is stressed in order to adequately understand and identify wind-tunnel flow quality requirements and effects on data quality, accuracy, and adequacy. The importance of not limiting the identification of potential data errors and measurement uncertainties to just those which can be currently quantified with existing analytical and computational methods is also stressed, as is the importance of understanding the aerodynamic design and validation process in which the data is being used, and the risk involved in the particular design being investigated. Additional considerations

which need to be given attention when conducting some specialized types of tests (icing, semispan, open throat, etc.) are addressed. Examples of observed and easily-envisioned flow-quality variation effects on measured aerodynamic characteristics are presented. Lastly, prospects for improving tunnel flow quality through application of current advanced CFD capabilities are highlighted, as well as prospects for incorporating advanced test-section wall ventilation concepts to enable more reliable and cost effective high Reynolds number testing capabilities.
Derived from text
Aerodynamic Characteristics; Design Analysis; Fluid Dynamics; High Reynolds Number; Reynolds Number; Throats; Wind Tunnel Tests

19970029165 National Aerospace Lab., Marknesse, Netherlands
GENERAL DESIGN ASPECTS OF LOW SPEED WIND TUNNELS
Jaarsma, F., National Aerospace Lab., Netherlands; Aerodynamics of Wind Tunnel Circuits and their Components; Jun. 1997; 16p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Since the sixties NLR was considering conceptional layouts and airline diagrams for the next generation low speed wind tunnels. This has resulted in the construction of a multi-purpose pilot facility in the early seventies. Based on the experiences gained from this facility, three major wind tunnels have been realized and are in full operation to great satisfaction of the operators and users: namely the DNW (1980) and LST (1983) facilities in the North East Polder in The Netherlands and the ILST (1987) near Jakarta in Indonesia. In this report the general design considerations in terms of aerodynamic and testing requirements are reviewed and are compared with the actual achievements. Also other operational aspects, such as logistics, acoustics, local constraints, and model supports are considered. From these aspects some lessons learned are concluded and recommendations made.
Derived from text
Low Speed Wind Tunnels; Construction; Airline Operations; Aerodynamic Characteristics; Acoustics

19970029166 Defence Research Agency, Farnborough, United Kingdom
THE AERODYNAMIC AND STRUCTURAL DESIGN OF THE DRA 5-METRE AND ONERA F1 LOW-SPEED PRESSURISED WIND TUNNELS
Woodward, D. S., Defence Research Agency, UK; Francois, G., Office National d'Etudes et de Recherches Aerospatiales, France; Taylor, N. J., Defence Research Agency, UK; Jun. 1997; 48p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes the aerodynamic and structural design of two pressurised low-speed tunnels built in the 1970's to achieve a Reynolds number of 6 x 10(exp 6) and, at the same time, to enable the effects of compressibility and scale to be studied independently in tests of aircraft models in take-off and landing configurations. Despite being designed to similar specifications and providing comparable levels of flow quality, productivity and customer confidentiality, the tunnels differ significantly in several important aspects of their design. The principal features of the two designs are reviewed and a few examples of the compressibility and scale effects that have emerged from the test programmes in each tunnel are presented.
Author
Aircraft Models; Compressibility Effects; Reynolds Number; Structural Design; Wind Tunnels

19970029167 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia
SUBSONIC WIND TUNNEL WITH FLOW SPEED PULSATION
Ryabokon, M. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Malyk, A. G., Tsentralni Aerogidrodinamicheskii Inst., Russia; Jun. 1997; 8p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A number of calculations and experiments within the program of developing a subsonic wind tunnel with flow speed pulsation in the test section were carried out at TsAGI. The wind tunnel was designed to perform aerodynamic tests of models in regularly fluctuating flows within the Mach number range up to 0.9 with the fluctuation amplitude up to 40% of the mean flow velocity amd the frequency of pulsations up to 20 Hz. One of the possible concepts of developing a wind tunnel with flow speed pulsation was used. Speed pulsation is generated using rotating elliptic shafts located parallel in one of the wind tunnel cross sections downstream of the test section. The air is injected into the wind tunnel from the atmosphere by means of an ejector. The results obtained were applied for designing a wind tunnel prototype with the 0.4 (W)x 0.7(H) m test section. Special attention in developing the wind tunnel was given to the problem of obtaining the velocity pulse shape in the test section close to the sine curve. For this purpose special correcting devices were introduced in the wind tunnel structure. Investigation showed that shock waves can be generated in pulsing flow at transonic flow velocities. The upper velocities at which no shock waves are generated have been determined.
Author
Aerodynamic Characteristics; Shock Waves; Rotating Shafts; Prototypes; Mach Number; Flow Velocity

19970029168 Politecnico di Milano, Dipt. di Ingegneria Aerospaziale, Milan, Italy
AERODYNAMIC DESIGN OF A CIVIL-AERONAUTICAL LOW SPEED LARGE WIND TUNNEL
Gibertini, G., Politecnico di Milano, Italy; Gasparini, L., Politecnico di Milano, Italy; Zasso, A., Politecnico di Milano, Italy; Jun. 1997; 10p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The new Civil-Aeronautical Low Speed Large Wind Tunnel is presented, which will be constructed in the near future at the Politecnico di Milano. This unconventional facility will allow for both civil environmental and aeronautical researches, respectively in a very large (14 x 4 m) low-speed test section and in a conventional high-speed test section (4 x 4 m). Based on the results of preliminary tests on a 1:9 scale model the design of some critical components was reviewed. This includes the numerical optimisation of the contraction ahead of the aeronautical test section, the inverse design of a new thick section for the corner vanes and an improved configuration of the bends upstream the civil-environmental test section. Tests performed to check the effectiveness of the proposed modifications, although showing that some work is still needed to fulfill the specified requirements, confirmed the feasibilty of this very peculiar wind tunnel.
Derived from text
Aerodynamics; Low Speed Wind Tunnels; Test Chambers; Optimization; Low Speed; High Speed

19970029169 Italian Aerospace Research Center, Capua, Italy
EXPERIMENTAL AND COMPUTATIONAL AERODYNAMICS APPLICATIONS FOR AN ICING WIND TUNNEL DESIGN
DeGregorio, F., Italian Aerospace Research Center, Italy; Esposito, B., Italian Aerospace Research Center, Italy; Mingione, G., Italian Aerospace Research Center, Italy; Vicini, A., Italian Aerospace Research Center, Italy; Jun. 1997; 10p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Italian Center for Aerospace Research is committed to the design and construction of a new icing wind tunnel (IWT). The main feature of an icing wind tunnel with respect to a traditional aerodynamic one is to have a heat exchanger to cool the air flux, and a spray-bar, normally located in the settling chamber, to generate water droplets simulating the supercooled water droplets clouds that can be encountered in flight conditions. The IWT will have peculiar characteristics, such as flight altitude pressure and humidity control, and large droplet simulation (larger than those indicated in present FAA regulations). The need for these features has been identified in the preliminary design phase, and their impact on the design has thus been evaluated. In this paper a short description of the main characteristics of the CIRA IWT will be given, and some of the experimental and theoretical studies that have been carried out during the feasibility study will be illustrated.
Derived from text
Computational Fluid Dynamics; Altitude Control; Settling; Ice Formation; Flight Conditions; Drops (Liquids); Drop Size

19970029170 Boeing Co., Aerodynamics, Noise and Propulsion Lab., Seattle, WA United States
DEVELOPMENT OF BOEING RESEARCH AERODYNAMIC ICING TUNNEL CIRCUIT
Chintamani, Seetharam, Boeing Co., USA; Delcarpio, Danny, Boeing Co., USA; Langmeyer, Greg, Boeing Co., USA; Jun. 1997; 28p; In

English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

There is a general understanding that aircraft design is a mature technology. All leading airframe manufacturers produce a high quality product, with a blend of sophisticated computational fluid dynamics programs and extensive wind tunnel tests. Prediction of flight characteristics and performance is usually made with previous in-house methodology backed with years of experience. On closer examination, however, there are areas where significant improvement can be made. Improvement opportunities exist for current processes in all phases of product development and manufacture. Better processes result in substantial reduction in cost and time. One of the areas was a close examination of the certification process relating to aircraft icing. Until 1990 an airframe manufacturer was required to fly the airplane through the cloud characterized by the FAA regulation (FAR Part 25) to obtain realistic ice shapes on relevant airplane parts, such as wings, horizontal and vertical tails and ram air turbines, etc. Based on the shapes of accreted ice during flight, molds were prepared. Demonstration of handling qualities is carried out with the shapes derived from the natural icing tests, attached to appropriate locations of the airplane. Flight testing of an airplane to extract the ice shapes in order to estimate the performance degradation and demonstration of airworthiness is a very tedious and expensive process. The Boeing Company, with the support of the FAA, proposed to simplify the airworthiness certification process on aircraft icing. The first part of the process is the extraction of the shape of ice accretion on airplane components. The FAA has issued guidelines for the development of ice shapes in the wind tunnel instead of by flight testing. The FAA emphasized that in order to establish 'certifiable' quality data, the flow qualities of the new tunnel must be equal to or superior in comparison to the NASA Lewis Icing Research Tunnel. The Aerodynamics Laboratory and Mechanical Systems Laboratory of the Boeing Company decided to modify an existing low-speed research tunnel to include icing test capability in addition to conducting basic low-speed aerodynamic research. In order to achieve good flow quality, particularly through the modification of the existing facility, the wind tunnel designer is faced with interesting design challenges. This paper describes some unique designs of the tunnel components and the results of the calibration.

Author

Aerodynamics; Aircraft Design; Aircraft Icing; Aircraft Reliability; Computational Fluid Dynamics; Controllability; Flight Characteristics; Ice Formation; Stabilizers (Fluid Dynamics); Wind Tunnel Tests

19970029171 Central Inst. of Aviation Motors, Moscow, Russia

NEW TEST CELL DESIGN METHODS BASED ON INTEGRATED USAGE OF CALCULATED AND EXPERIMENTAL RESEARCHES

Kabakov, I. I., Central Inst. of Aviation Motors, Russia; Timoshin, A. N., Central Inst. of Aviation Motors, Russia; Jun. 1997; 10p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The results of integrated usage of mathematical and physical models to develop aerodynamic lay-outs of altitude and sea-level test cell components to test aviation engines are presented in the report. Performances of dissipative layers in the intake manifold are investigated. New schemes of effective gas flow mixing are developed. The method for pressure control by inducing jets in the pressure cell is given. The basic principles for engine simulators creation are shown.

Author

Mathematical Models; Altitude Tests; Jet Control

19970029172 Office National d'Etudes et de Recherches Aerospatiales, Paris, France

ETW AERODYNAMIC DESIGN: A CASE STUDY

Bouis, X., Office National d'Etudes et de Recherches Aerospatiales, France; Prieur, J., Office National d'Etudes et de Recherches Aerospatiales, France; Tizard, J. A., Tizard (J. A.), UK; Hefer, G., ETW G.m.b.H., Germany; Jun. 1997; 14p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The European Transonic Windtunnel ETW offers flight/near flight Reynolds numbers. This paper addresses the definition of the basic specification and the expansion of this basic specification into an overall aerodynamic design and concept of control of the facility. The rationale used in the definition of various tunnel components is explained and an overview of some of the studies and calculation methods employed to achieve the design of different sections of the tunnel are given. The need of test rigs is discussed and some details of the use of the pilot facility PETW in the development of the design are presented. The calibration methods and calibration results showing that the design was successfully implemented are outlined and show the excellent quality that is currently being achieved and demonstrate that the design concept works up to full flight Reynolds numbers.

Derived from text

Integrated Mission Control Center; Transonic Flight; Aerodynamics

19970029173 Office National d'Etudes et de Recherches Aerospatiales, CERT, Toulouse, France

CONTROL AND MATHEMATICAL MODEL OF TRANSONIC WIND TUNNELS *MODELISATION ET PILOTAGE DES SOUFFLERIES TRANSSONIQUES*

Gobert, J. L., Office National d'Etudes et de Recherches Aerospatiales, France; Jun. 1997; 8p; In French; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Presently, a large part of wind tunnel testing concerns the subsonic and transonic ranges for civil transport aircraft; one particular topic in such type of tests is that the flow parameters (Mach number, pressure, temperature) require to be controlled with a high level of accuracy. Then, today's wind tunnels shall be equipped with an efficient control system capable to take the best of their performances. During the acquisition of data on the model, the flow parameters shall be maintained within small tolerances, leading to a restricted number of tests performed with a high level of quality in very well defined conditions. The operations of interpolation to be carried out during data post-processing are minimized and the task of the aerodynamicists while scaling up the results to the actual flying conditions shall be easier. On another hand, dead times during the transition periods when going from one set point to another one shall be reduced to keep the running costs as low as possible. This document presents a control technic which was originally developed at ONERA and then adapted, improved and implemented in a recently built and large facility, the European Transonic Wind tunnel ETW erected in Cologne (Germany). During the first years of the ETW design, a computer dynamic model of the facility has been developed to support the control activities. This model, based on the knowledge of the aerodynamic phenomena present in the wind tunnel circuit, simulates the effects of heat transfers and temperature propagation along the circuit as well as the breathing of the Plenum Chamber. It performs a time simulation of the wind tunnel physical phenomena; at each time step, the parameter variations are integrated using the thermodynamics equations. In a following stage, control laws have been studied to drive the into the wind tunnel control system in order to drive the actual process. Results of tests recorded on the actual plant are included in the document. At the present time, a task is undertaken to enhance the performances of the ONERA S1 and S2 wind tunnels. The way this technic can be adapted to existing wind tunnels in order to trace the possible weaknesses of the facility, to correct them and improve the overall behavior are quickly discussed and supported by results of simulation. It is demonstrated that this type of dynamic model can be used to design or redesign, set up and tune a transonic wind tunnel control system in an efficient and economical way as well as to improve the overall performances. Use of this technique enabled to run the ETW facility almost from the first days in automatic mode minimizing considerably the time required to tune the control system and provide quickly satisfactory results.

Author

Aerodynamic Characteristics; Computerized Simulation; Dynamic Models; Flow Characteristics; Mach Number; Thermodynamics; Transonic Wind Tunnels

19970029174 Academy of Sciences (USSR), Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR

ELABORATION OF CRYOGENIC TRANSONIC SHORT-DURATION WIND TUNNEL AT ITAM

Zvegintsev, V. I., Academy of Sciences (USSR), USSR; Omelaev, A. I., Academy of Sciences (USSR), USSR; Jun. 1997; 10p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The research program directed to the transonic cryogenic wind tunnel creation have been carried out at the ITAM. Two variants of short-duration cryogenic wind tunnels have been worked out as paper projects. One of them is constructed as a classic blow-down wind

tunnel. Here the cold air (or nitrogen) is collected within thermoinsulated storage vessels at a pressure up to 20 MPa and temperature 190 K. During a run the gas is flowing into the settling (plenum) chamber wherein its pressure falls down to 1 MPa and temperature to 120 K due to throttling effect. The cold gas flowing out is accompanied by high pressure and ambient temperature air flowing into the accumulator thus practically constant stagnation parameters of flow will be kept during the run. Another variant is constructed as a modified Ludwieg tube tunnel. The modification consists of an additional reservoir attached to the high-pressure tube with a perforated baffle (wall) between them. Such a device allows one to eliminate reflected rarefaction waves and to prolong useful running time. An experimental program has been initiated at short-duration impulse gasdynamic facility where the first mentioned variant of transonic wind tunnel was checked out. A transonic flow with good uniformity after throttling device was brought off was achieved during these tests. The experiments carried out at TsAGI (Moscow) allow one to establish the conditions when the reflected wave is eliminated for the second version of the tunnel.
Author
Transonic Wind Tunnels; Accumulators; Cryogenic Wind Tunnels; Stagnation Flow; Throttling; Reflected Waves; Plenum Chambers

19970029175 Central Research Inst. of Machine Building, Kaliningrad, Russia
THE IMPULSE TRANSONIC WIND TUNNEL U-11: NEW EFFECTIVE TECHNOLOGY FOR GENERATION OF SUB-, TRANS- AND SUPERSONIC GAS FLOW
Kislykh, V. V., Central Research Inst. of Machine Building, Russia; Koudriavtsev, V. V., Central Research Inst. of Machine Building, Russia; Petrova, O. V., Central Research Inst. of Machine Building, Russia; Puchkov, V. V., Central Research Inst. of Machine Building, Russia; Jun. 1997; 14p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

New technology for generation of sub-, trans-, and supersonic gas flows along with technology based on the impulse transonic wind tunnel ITT U-11 (nozzle dia 0.8) operated at TSNIIMASH are presented. The most important units and systems of the wind tunnel, test results on flow parameters in the working section and also their comparison with the same parameters for usual intermittent wind tunnels are described. The comparison has shown that suggested technology and the wind tunnel design, which allow to reduce essentially wind tunnel dimensions and power consumption, may be used for development of special rigs for complex investigation of aero-gas-dynamic and acoustic characteristics of flight vehicle models with engine jet simulation.
Author
Flow Characteristics; Gas Flow; Supersonic Flow; Transonic Wind Tunnels; Wind Tunnel Tests

19970029176 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany
A NEW TOOL FOR SCREEN INTEGRATION IN INTERNAL FLOW SYSTEMS AND ITS APPLICATION TO WIND TUNNEL DESIGN
Seltsam, M. M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Jun. 1997; 12p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

To consider mesh screens in internal fluid flow a numerical method is modified. A Navier-Stokes method with the standard k-e turbulence model is employed. The new extended numerical method is applied to wide-angle diffuser flow. The comparison of calculated diffuser flows with experimental results yields the requisite correspondence. The numerical and experimental investigations lead to a modification of the actual windtunnel. After realization of the modification a remarkable reduction of spatial velocity disturbances is achieved. The capability of screens to suppress turbulence is displayed by comparison of turbulence level distributions before and past the optimization of the settling chamber.
Author
Navier-Stokes Equation; Turbulence Models; Mesh; Fluid Flow

19970029177 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia
ADAPTIVE-WALL PERFORATED TEST SECTION FOR TRANSONIC WIND TUNNELS
Neyland, V. M., Tsentralni Aerogidrodinamicheskii Inst., Russia; Ivanov, A. I., Tsentralni Aerogidrodinamicheskii Inst., Russia; Semenov, A. V., Tsentralni Aerogidrodinamicheskii Inst., Russia; Semenova, O. K., Tsentralni Aerogidrodinamicheskii Inst., Russia; Amirjanz, G. A., Tsentralni Aerogidrodinamicheskii Inst., Russia; Jun. 1997; 16p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The review will be presented on the experimental study of using variable wall porosity for the methodical and productive wind tunnel testing of the aircraft models. Except for brief discussion of present state in this area the main reported results are based on the experience of exploitation of different porous wall test sections of TsAGI T-128 wind tunnel. This facility has 4 interchangeable test sections, each of them equipped with the specially designed variable porous walls according to the testing specialty. For example, test sections NI and N2 have each 128 controlled sections designed as overlapping porous surfaces with the open area ratio variation from 0 to 18%. Test section N3 is equipped with longitudinally- variable slots, open area ratio changing from 0 to 13%. This test section is used for 2-D airfoil testing and has all the necessary instrumentation: controlled wall boundary layer suction upstream from the model, 2 degree of freedom wake survey mechanism, pressure measurement system for 1200 points on the basis of electronic modules etc. Test section N5 serves for aeroelastic model testing. Adjustable wall porosity is designed only in model location area. It is used not only for wall interference reduction but also as a flow excitation source. As an example of different adaptive-wall test sections, data are presented on two geometrically-similar A4 airfoils tested in the test section N3. Reference model AEDC-2, tested in section NI, is compared to the 1 6-T wind tunnel test of the same model. Also, results of the "flying" strut test in section NS is presented.
Author
Aerodynamic Interference; Aeroelasticity; Aircraft Models; Airfoils; Boundary Layers; Degrees of Freedom; Transonic Wind Tunnels; Wind Tunnel Tests

19970029178 Institute for Aerospace Research, Aerodynamics Lab., Ottawa, Ontario Canada
ALLEVIATION OF AXIAL STATIC PRESSURE GRADIENTS IN 2D PERFORATED TEST SECTION OF IAR BLOWDOWN WIND TUNNEL
Tang, F. C., Institute for Aerospace Research, Canada; Chan, Y. Y., Institute for Aerospace Research, Canada; Jun. 1997; 8p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The complicated flow mechanism in the empty porous 1AR 2D test section including the plenum chamber and downstream diffuser section was studied and postulated. The forward-facing inclined holes in the test section top and bottom walls resulted in the plenum pressure being higher than the test section static pressure. The original test section side walls were too short and a big opening was formed between the test section and the downstream diffuser. The plenum air mass was readily entrained through this opening by the free jet flow formed downstream of the test section. The removal of the plenum air mass from this opening effectively lowered the plenum pressure resulting in the outflow phenomenon in the test section. With the presence of a long side wall extension the opening between the test section and the downstream diffuser section would be shortened. The plenum mass flow was greatly reduced as entrainment was decreased due to a shorter free jet flow. A pressure equilibrium condition between the plenum and the test section was thus established resulting in a constant pressure distribution along the test section. This paper presents the results obtained during the commissioning of this extended side wall configuration and the subsequent modifications made to it. A close to optimum configuration for the IAR 2D test section extension has been found.
Author
Blowdown Wind Tunnels; Air Masses; Free Jets; Jet Flow; Pressure Distribution; Pressure Gradients; Static Pressure

19970029179 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia
EVALUATING ANALYTICALLY AND EXPERIMENTALLY THE GAS DYNAMICS OF TRANSONIC WIND TUNNELS WITH DEVICES FOR AIR EVACUATION FROM PLENUM CHAMBER
Verkhovsky, V. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Lyzhin, O. V., Tsentralni Aerogidrodinamicheskii Inst., Russia;

Pasova, Z. G., Tsentralni Aerogidrodinamicheskii Inst., Russia; Jun. 1997; 6p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The report provides results of experimental evaluation of flow in a transonic wind tunnel with forced suction from the plenum chamber surrounding a perforated test section. It is shown that the test section exit part features an air outflow into the plenum chamber, this decelerates flow, increases pressure, and decreases the Mach number at the entry into the main subsonic diffuser of the wind tunnel. In this case, total pressure losses become notably less. Also reported are results of experimental investigations into operation of a large wind tunnel with the suction system which extends the ranges of Mach and Reynolds numbers and reduces total pressure losses.

Author

Plenum Chambers; Transonic Wind Tunnels; Subsonic Wind Tunnels; Reynolds Number; Gas Dynamics

19970029180 ETW G.m.b.H., Cologne, Germany

ADAPTIVE SLOTS: AN ALTERNATIVE CONCEPT TO REDUCE WALL INTERFERENCE

Quest, J., ETW G.m.b.H., Germany; Nitsche, W., Technische Univ., Germany; Mignosi, A., Centre d'Etudes et de Recherches, France; Jun. 1997; 10p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

An alternative concept to reduce wall interference in wind-tunnel testing by means of adaptive slots is presented and its benefits are highlighted by means of experimental as well as numerical investigations. The qualification of the 3d-NAVIER-STOKES code employed for the parametric numerical investigations is demonstrated by comparison with Laser 2-focus and surface pressure measurements. The effectiveness of a single central adaptive slot is proved for a convex profile as well as for a body of revolution by referencing the results to 2d wall adaptions. For a simplified 3d slot, adaptation featuring 6 slots on each top and bottom wall have better agreement with the free-stream solution than for the 2d wall adaptation that was achieved.

Author

Aerodynamic Interference; Free Flow; Lasers; Pressure Measurement; Wind Tunnel Tests

19970029181 City Univ., London, United Kingdom

PROGRESS IN DETERMINING WALL-INDUCED INTERFERENCE IN SLOTTED-LINER WIND TUNNELS USING MEASURED WALL CONDITIONS

Freestone, M. M., City Univ., UK; Sykes, D. M., City Univ., UK; Jun. 1997; 12p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Further work and analysis relating to a previously proposed scheme for determining slotted-liner wall-induced interference at subsonic speeds are presented. The scheme utilises measurements of wall (slat) pressures and values of the velocity-component normal to the liner measured in the plane of the liner along a slot centre line. This flow component is measured by a probe, and longitudinal distributions of the normal velocity are obtained both from traverses and multiple point measurements. With a three-dimensional test configuration, measurements would be made on each slat and slot, but in the present tests with a two-dimensional aerofoil the slats and slots in each wall (roof and floor) are assumed to behave equally. Assessment of the results of utilising the scheme is based on comparisons of aerofoil pressures at corrected conditions of Mach number and (three-quarter chord) incidence. More detailed assessment by other means is suggested. The scheme appears reliable for the range of test conditions undertaken, and these more than adequately cover conditions likely to be found in the large three-dimensional test facilities for which the method is intended.

Author

Aerodynamic Interference; Airfoils; Mach Number; Slotted Wind Tunnels; Subsonic Speed; Wall Flow; Wall Pressure

19970029182 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia

AERODYNAMIC DESIGN OF AXIAL-FLOW FANS FOR SUBSONIC WIND TUNNELS

Brusilovsky, I. V., Tsentralni Aerogidrodinamicheskii Inst., Russia; Jun. 1997; 8p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The report highlights features of wind tunnel fans with axial annular diffusers, as well as relations for defining fan parameters (including the total pressure loss factor) with the aid of the equivalent diffuser length and the total pressure loss coefficient of a planar diffuser. Test data on planar and annular diffusers (including data on the annular diffusers tested with fans) are compared. Foundations of fan aerodynamic design are provided; this is subdivided into two principal stages: (1) determining the basic parameters (volume-averaged axial flow-speed coefficient, theoretical pressure coefficient, and two new parameters: the prewhirl upstream of an impeller and the residual whirl downstream of an outlet guide vane) as well as the fan hub diameter; (2) shaping the guide vanes and impeller blading. The operational envelope is outlined; taking parameters in this domain ensures creating a fan with really separation free flow about blades both at a rated regime at a maximum possible efficiency and over a certain domain around the rated regime. The design parameters are selected, and efficiency evaluated, in the general form for a complete fan configuration comprising an inlet guide vane (IGV), the impeller, and an outlet guide vane (OGV). Results for configurations without one or two guide vanes are the corresponding particular cases. Expressions for optimizing the design parameters and the respective efficiency are derived. Theoretical and experimental values of the two new parameters of flow whirl are compared. The shaping procedure (i.e., defining the airfoil setting angle, shape, curvature, the blade array spacing, rated airfoil angle of attack, total number and shapes of the blades) is based on generalized test data; the relations allow for radial blading-variation and the "distance" to the maximum pressure on the fan characteristic curve. Airfoil setting angles and radial variation of airfoil curvature are proposed to be deEmed from theoretical data on airfoil arrays on the basis of a unified method for all bladed components with arbitrary array density. This aerodynamic design method developed at GOSNITs TsAGI has been used and improved for more than 45 years and has been comprehensively verified.

Author

Subsonic Wind Tunnels; Turbofans; Pressure Ratio; Impellers; Guide Vanes; Free Flow; Flow Coefficients; Curvature; Axial Flow; Angle of Attack

19970029183 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia

EJECTOR-DRIVEN WIND TUNNELS

Arkadov, Y. K., Tsentralni Aerogidrodinamicheskii Inst., Russia; Roukavets, V. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Jun. 1997; 10p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The experience accumulated at the Central Aerohydrodynamic Institute for many years in calculating, designing, and running wind tunnels in which pressure difference is produced by a jet ejector-compressor, is analyzed. Theories for optimal gas ejectors and their systems are given, new schemes of gas ejectors of improved performance are discussed, and problems of improving economic efficiency of the 'wind tunnel-gas ejector' system are considered. Examples of successful use of ejectors as major drivers of subsonic, trans-, and hypersonic wind tunnels are presented.

Author

Wind Tunnels; Compressors; Ejectors; Wind Tunnel Apparatus; Systems Engineering; Design Analysis; Gas Jets

19970029184 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia

IMPROVING TRANSONIC WIND TUNNEL COMPRESSOR OPERATION BY MEANS OF GUIDE VANE ANGLE OPTIMIZATION

Kukinov, A. G., Tsentralni Aerogidrodinamicheskii Inst., Russia; Dyadchenko, G. E., Tsentralni Aerogidrodinamicheskii Inst., Russia; Lunyov, A. A., Tsentralni Aerogidrodinamicheskii Inst., Russia; Panasenko, V. S., Tsentralni Aerogidrodinamicheskii Inst., Russia; Jun. 1997; 6p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The implementation of adjustable guiding vanes (AGV) for optimizing the angle of setting for improvement of the transonic wind tunnel's compressor characteristics is considered. Experimental research results of the gas dynamic characteristics of the T-128 wind tunnel's compressor and dynamic stress in its blades are presented.

The necessity of monitoring the operation point position in the compressor operating envelope for providing its stable operation is shown.
Author
Transonic Wind Tunnels; Guide Vanes; Wind Tunnel Apparatus; Compressors; Systems Engineering; Gas Jets; Angles (Geometry); Design Analysis

19970029185 Machine-Building Design Bureau, Moscow, Russia
DEVELOPMENT OF CLOSE-CIRCUIT SUBSONIC WIND TUNNEL WITH DIAMETRAL FAN
Korovkin, A. G., Tsentralni Aerogidrodinamicheskii Inst., USSR; Savchuk, V. D., Machine-Building Design Bureau, Russia; Kuroles, V. K., Machine-Building Design Bureau, Russia; Jun. 1997; 8p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In this paper the features of air flow in a diametral fan (DF) contour and its aerodynamic characteristics are reported. The field of application for the DF in the wind tunnels is determined. The results of experimental investigations of DF geometrical parameters effect on DF aerodynamic parameters are given. The performance data of the MBDB Raduga compact subsonic wind tunnel and the Laboratory Training Aerodynamic Complex (ULAK) for Technical Schools which is developed on its base are offered. The method of approximate simulation of following a body contour with a liquid with free surface in a wide range of F(z) numbers for subsonic wind tunnels is proposed, and the possibility of DF use in the installations of this type is considered.
Author
Subsonic Wind Tunnels; Aerodynamic Characteristics; Wind Tunnel Apparatus; Systems Engineering; Design Analysis; Compressor Rotors; Air Flow; Circuits

19970029186 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia
EXPERIMENTAL STUDY OF A LOW-SPEED WIND TUNNEL TEST SECTION WITH A FREE JET
Roukavets, V. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Byrkin, A. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Iskra, A. L., Tsentralni Aerogidrodinamicheskii Inst., Russia; Filatov, A. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Troitsky, V. V., Tsentralni Aerogidrodinamicheskii Inst., Russia; Ponomaryova, V. C., Tsentralni Aerogidrodinamicheskii Inst., Russia; Holzdeppe, D., Turbo-Luftechnik G.m.b.H., Germany; Papenfuss, H. D., Ruhr Univ., Germany; Barbagallo, D., Italian Aerospace Research Center, Italy; Jun. 1997; 14p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Results of experimental study of various configurations of the subsonic wind tunnel test section with a free jet and Eiffel chamber are presented in order to determine its optimum variant corresponding to minimum values of velocity and pressure pulsation, hydraulic losses and flow non-uniformity in the model location zone. At a given reduced jet length the parameters of the test section configuration were provided by varying the relation of the diffuser entry section area to the nozzle exit section area and by variations of the collector placed in front of the diffuser. Different forms of the collector were studied: one-piece contracting collector, contracting collector adjusted along the angle and collector with parallel walls. From the collectors investigated the best in the aggregate of the flow efficiency criteria is the one-piece contracting collector with an angle of inclination of walls alpha(c) is approx. equal to 14 degrees and an optimum relative value of the gap between it and the diffuser is approx. equal to 0.2.
Author
Subsonic Wind Tunnels; Test Chambers; Free Jets; Wind Tunnel Apparatus; Wind Tunnel Tests; Systems Engineering; Design Analysis; Wind Tunnel Models

19970029187 Duits-Nederlandse Windtunnel, North East Polder, Netherlands
MODEL AND FULL SCALE INVESTIGATIONS OF THE LOW FREQUENCY VIBRATION PHENOMENA OF THE DNW OPEN JET
Holthusen, H., Duits-Nederlandse Windtunnel, Netherlands; Kooi, J. W., Duits-Nederlandse Windtunnel, Netherlands; Jun. 1997; 8p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The German-Dutch Wind Tunnel DNW is a large low speed wind tunnel with three different sized closed and one open test sections (Open Jet). Already during the first calibration phase of the Open Jet in 1981, it soon became clear that the maximum jet velocity was not limited by the available fan power, but by the maximum allowable vibrations of the Test Hall which surrounds the Open Jet. Due to low-frequency pressure fluctuations generated by the Open Jet, the vibrations reached levels which could become critical for the Test Hall structure. In order to be able to increase the maximum velocity beyond this 80 m/s an extensive research programme was executed in the 1:10 scaled pilot wind tunnel of DNW. The objective of this programme was to find the sources of the observed low frequency pressure fluctuations and to verify different configurations for their potential to reduce the vibration level. The tested configurations included a number of well-known nozzle modifications as well as a new configuration with so-called tetrahedrons. The effect of modifications of the collector geometry and the effect of extra bleeding was also investigated. After completing the tests in the pilot wind tunnel, the most promising solutions were tested in the DNW. It turned out that the results found in the two wind tunnels correlated very well. A surprising outcome was that in both tunnels the tetrahedrons increased the jet speed without a noticeable reduction of the usable cross section of the Open Jet and without increasing the acoustic background noise level.
Author
Low Speed Wind Tunnels; Pressure Oscillations; Test Chambers; Wind Tunnel Apparatus; Systems Engineering; Design Analysis; Structural Vibration; Jet Flow; Acoustic Frequencies; Background Noise; Tetrahedrons

19970029188 Tsentralni Aerogidrodinamicheskii Inst., Moscow, USSR
SELF-OSCILLATION FLOW CONTROL IN FREE-JET WIND TUNNELS
Ginevsky, A. S., Tsentralni Aerogidrodinamicheskii Inst., USSR; Jun. 1997; 12p; In English; See also 19970029162
Contract(s)/Grant(s): RFFI-96-02-19577; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In wind tunnels with the open test section strong, self-oscillations arise at certain flow velocities which are accompanied by a sharp increase of pressure and velocity pulsations in the test section. Traditional methods of self-oscillation control do not provide complete suppression. In the work presented the acoustic methods of self-oscillation control (their suppression or generation), based on the coherent jet structure response to periodic excitation have been investigated. The experiments were carried out in four wind tunnels with different outer diameters of the exhaust nozzle d = 0.15-2.2 m.
Author
Wind Tunnels; Self Oscillation; Test Chambers; Unsteady Flow; Free Jets; Wind Tunnel Nozzles; Flow Stability; Design Analysis; Systems Engineering; Air Ducts

19970029189 Case Western Reserve Univ., Mechanical and Aerospace Engineering, Cleveland, OH United States
TURBULENCE AND NOISE CRITERIA AND THEIR IMPLEMENTATION IN NWTC-TYPE WIND TUNNELS
Reshotko, Eli, Case Western Reserve Univ., USA; Saric, William S., Arizona State Univ., USA; Nagib, Hassan M., Illinois Inst. of Tech., USA; Jun. 1997; 14p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper considers the establishment of turbulence and noise criteria as a function of Mach number and total pressure for utilitarian low-speed and transonic wind tunnels of the National Wind Tunnel Complex (NWTC) class facilities such that boundary-layer transition models likely to be tested in them will not be contaminated by the flow environment. Aside from the NWTC tunnels themselves, the ideas in this paper apply to upgrades and revisions of existing tunnels such as the NASA-Ames 11-foot Unitary Tunnel and the AEDC 16T tunnel.
Author
Transonic Wind Tunnels; Low Speed Wind Tunnels; Turbulence; Boundary Layer Transition; Noise (Sound); Boundary Layer Flow; Design Analysis; Wind Tunnel Apparatus

19970029190 Office National d'Etudes et de Recherches Aerospatiales, Meundon, France
DESIGN AND VALIDATION OF A QUIET SUPERSONIC WIND TUNNEL *CONCEPTION ET QUALIFICATION DE LA SOUFFLERIE SILENCIEUSE: R1CH DE L'ONERA*
Papirnyk, O., Office National d'Etudes et de Recherches Aerospatia-

les, France; Rancarani, G., Office National d'Etudes et de Recherches Aerospatiales, France; Delery, J., Office National d'Etudes et de Recherches Aerospatiales, France; Arnal, D., Centre d'Etudes et de Recherches, France; Jun. 1997; 16p; In French; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The R1Ch blow down wind tunnel was recently converted into a quiet supersonic wind tunnel at Mach 3. In order for the boundary layers on the nozzle wall to remain laminar, the following tasks were accomplished: noise minimization coming from the upstream circuit, realization of suction upstream of the throat to eliminate the boundary layer in the contraction, optimization of the nozzle shape calculated in order to reduce Gortler vortex, and realization of a surface quality to avoid triggering of transition due to the roughness. The theoretical, numerical and technological works resulting in the realization of the wind tunnel, are presented with the description of the facility. A preliminary validation of the wind tunnel was done with: measurement of pressure fluctuations in the stilling chamber, probing of boundary layer upstream of the nozzle throat, probing of pitot pressure and flux measurement on plane plate in the test section, and probing of boundary layer in the nozzle exit plane.

Author

Supersonic Wind Tunnels; Test Chambers; Wind Tunnel Nozzles; Pressure Oscillations; Design Analysis; Vortices; Nozzle Design

19970029191 NASA Ames Research Center, Moffett Field, CA United States

CHARACTERISTICS OF THE NASA-AMES LAMINAR FLOW SUPERSONIC WIND TUNNEL FOR UNIQUE MACH 1.6 TRANSITION STUDIES

Wolf, Stephen W. D., MCAT Inst., USA; Laub, James A., NASA Ames Research Center, USA; Jun. 1997; 18p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Flow quality measurements have been performed in the unique Laminar Flow Supersonic Wind Tunnel (LFSWT) to examine both mean and dynamic characteristics. The intent was to provide the necessary flow information about this ground test facility, to support meaningful transition research at Mach 1.6 and flight unit Reynolds numbers. This paper is intended to assist other experimentalists with similar goals of characterizing low-supersonic test environments. An array of instrumentation has been used to highlight the importance of proper selection of pressure instruments and data acquisition procedures. We conclude that the test section is low-disturbance (based on classical standards of pressure disturbances less than 0.1% with no specified data bandwidth), and has uniform flow. This is confirmation that the quiet design features of the LFSWT are effective. However, characterization of the test section flow over a 0.25k-5Ok bandwidth shows that the disturbance levels can be greater than classical standards particularly for stagnation pressures less than 9.5 psia (0.65 bar) with low stagnation temperatures. Variability of the flow disturbances in the settling chamber and test section is contained in a narrow frequency bandwidth below 5k Hz, which is associated with resonant frequencies from the pressure reduction system. So far, these disturbances have not impacted transition along the tunnel walls or a 10 degrees cone. However, continual vigilance is required to maintain a known low-disturbance environment for transition research in the LFSWT. Furthermore, the formation of standards for flow quality measurements is strongly recommended, so that transition research can be better isolated from tunnel disturbances.

Author

Supersonic Wind Tunnels; Test Chambers; Uniform Flow; Laminar Flow; Supersonic Speed; Free Jets; Transition Flow; Wind Tunnel Apparatus; Noise (Sound)

19970029192 Academy of Sciences (USSR), Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR

FLUCTUATION CHARACTERISTICS OF FLOWS IN TEST SECTIONS OF HIGH-SPEED WIND TUNNELS

Lebiga, V. A., Academy of Sciences (USSR), USSR; Zinoviev, V. N., Academy of Sciences (USSR), USSR; Jun. 1997; 10p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The results of fluctuation structure study in test sections of wind tunnels in the wide range of velocity (from large subsonic up to supersonic) are presented in this paper. A correlation between characteristics of the boundary layer on the test section walls of the supersonic wind tunnel with fluctuations in the flow core is shown. Detailed characteristics of fluctuations in ventilated test sections are given for different types of walls (perforated, slotted, smooth rigid). The constant current hot-wire anemometer and developed at ITAM technique have been used for fluctuation measurements and interpretation of the results.

Author

Flow Characteristics; Test Chambers; Wind Tunnels; Flow Stability; Turbulence; Reynolds Number; Wind Tunnel Apparatus; Boundary Layers; Wind Tunnel Walls; High Speed

19970029193 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia

AERODYNAMIC DESIGN OF NOZZLES FOR SUBSONIC AND TRANSONIC WIND TUNNELS

Byrkin, A. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Ponomaryov, S. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Ponomaryova, V. S., Tsentralni Aerogidrodinamicheskii Inst., Russia; Filatov, A. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Jun. 1997; 10p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This report gives results of theoretical considerations and experimental research on gas flows in axisymmetric nozzles of sub- and transonic wind tunnels. Two classes of nozzle transverse contours were investigated at test section flow velocities corresponding to Mach numbers of M(infinity) = 0.1-1.0. Cross-section shapes for the first class of contours were calculated using the Witoszinski equation, and for the second class they were determined by the equations considered in the present report. It is shown that the flow pattern which takes place in the considered nozzles especially at nozzle entries, is not one dimensional. It is found, that the Witoszinski contour is unacceptable for a practical implementation of representative contraction factor and nozzle length-to-diameter ratio values; the reason is unacceptable negative longitudinal velocity gradient value on the wall near the nozzle entry, which can lead to boundary layer separation. Similar results are given for a gas flow in the nozzles having rectangular, circular, and octagonal transverse contours and also in the nozzle having circular transverse entry contour and octagonal transverse exit contour.

Author

Aerodynamic Characteristics; Subsonic Wind Tunnels; Transonic Wind Tunnels; Test Chambers; Nozzle Design; Nozzle Flow; Wind Tunnel Nozzles; Contours; Design Analysis; Gas Flow; Wind Tunnel Walls; Boundary Layer Separation; Nozzle Geometry

19970029194 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia

METHOD FOR THE CALCULATION OF 2D SUPERSONIC VARIABLE NOZZLE CONTOURS

Verkhovsky, V. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Jun. 1997; 6p; In English; See also 19970029162; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The report considers a supersonic adjustable nozzle including a rigid acceleration-section and a flexible smoothing-section. These are proposed to be designed by the method that ensures a Mach number field (within 1% error) in the characteristic rhomb for a certain Mach number range, while requiring only a few adjustment points (where hydraulic actuators are attached). The method is based on numerical analysis of flow in a nozzle whose flexible section is described by a cubic spline. Consideration is given to nozzles with a maximum angle of the acceleration section of 10 through 18 degrees, which are intended to provide the exit Mach number of 1.2 to 4.0. It is shown that using three or four adjustment points in nozzles with inclination angle of less than 12 degrees ensures the characteristic-rhomb flow nonuniformity of no greater than 0.5%, and for angle less than 17 degrees the flow nonuniformity does not exceed 1%. In order to allow for air

viscosity in nozzles designed to M less than 5.0, a general relation between the boundary layer displacement thickness and the Mach number is proposed.
Author
Supersonic Wind Tunnels; Nozzle Design; Nozzle Flow; Wind Tunnel Nozzles; Contours; Spline Functions; Design Analysis; Wind Tunnel Apparatus; Nozzle Geometry

19980018683 NASA Ames Research Center, Moffett Field, CA United States
SURVEY OF AEROTHERMODYNAMICS FACILITIES USEFUL FOR THE DESIGN OF HYPERSONIC VEHICLES USING AIR-BREATHING PROPULSION
Arnold, James O., NASA Ames Research Center, USA; Deiwert, George S., NASA Ames Research Center, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 16p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper surveys the use of aerothermodynamic facilities which have been useful in the study of external flows and propulsion aspects of hypersonic, air-breathing vehicles. While the paper is not a survey of all facilities, it covers the utility of shock tunnels and conventional hypersonic blow-down facilities which have been used for hypersonic air-breather studies. The problems confronting researchers in the field of aerothermodynamics are outlined. Results from the T5 GALCIT tunnel for the shock-on lip problem are outlined. Experiments on combustors and short expansion nozzles using the semi-free jet method have been conducted in large shock tunnels. An example which employed the NASA Ames 16-Inch shock tunnel is outlined, and the philosophy of the test technique is described. Conventional blow-down hypersonic wind tunnels are quite useful in hypersonic air-breathing studies. Results from an expansion ramp experiment, simulating the nozzle on a hypersonic air-breather from the NASA Ames 3.5 Foot Hypersonic wind tunnel are summarized. Similar work on expansion nozzles conducted in the NASA Langley hypersonic wind tunnel complex is cited. Free-jet air-frame propulsion integration and configuration stability experiments conducted at Langley in the hypersonic wind tunnel complex on a small generic model are also summarized.
Derived from text
Aerothermodynamics; Air Breathing Engines; Hypersonic Vehicles; Hypersonic Wind Tunnels; Shock Tunnels; Surveys

19980018692 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Lampoldshausen, Germany
TEST FACILITIES FOR LARGE RAMJETS
Koschel, W. W., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Heitmeier, F., Daimler-Benz Aerospace A.G., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 10p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Within the German Hypersonics Technology Program (GHTP) a subscale ramjet was to be ground tested in a free jet configuration. The propulsion system selection process for a hypersonic experimental flight vehicle will be briefly reviewed. A ramjet type propulsion system with subsonic combustion was chosen as the baseline configuration. The rationale of technology and component development will be presented. The final goal of the program was a ramjet test in the simulated flight Mach number range from Ma = 3.5 up to Ma = 6.8 in order to demonstrate the engine's steady state operation and thrust capability. A general concept for the ramjet ground testing was developed specifying as well the operational requirements for the engine characteristics as the test and measurement plan. A ramjet propulsion system with a ram combustor diameter of 500 mm was designed as the demonstrator engine. Based on the predefined specifications an evaluation of existing large scale test facilities was made including a total of 11 existing facilities in the USA, in Russia and in France. Engine installation and necessary adaptation of existing hardware were studied and discussed with the operators in detail. Major results of this facility evaluation study and lessons learned will be presented in the paper. The APTU wind tunnel of the AEDC at Tullahoma was finally selected for the planned tests of the full engine. Due to funding restrictions only the ram combustor with the variable geometry nozzle could be demonstrated in operation in the connected-pipe test facility at Ottobbrunn in Germany.
Derived from text
Ramjet Engines; Hypersonic Vehicles; Propulsion System Configurations; Test Facilities; Free Jets; Hypersonics

19980018694 NASA Langley Research Center, Hampton, VA United States
NASA AND ESA GROUND FACILITY SIMULATIONS OF SHUTTLE ORBITER AEROTHERMODYNAMICS
Muylaert, J., European Space Agency. European Space Research and Technology Center, ESTEC, Netherlands; Rostand, P., Dassault Aviation, France; Rapuc, M., Dassault Aviation, France; Paulson, J., NASA Langley Research Center, USA; Brauckmann, G., NASA Langley Research Center, USA; Trockmorton, D., NASA Langley Research Center, USA; Steijl, R., Technische Univ., Netherlands; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 16p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The paper reviews a combined numerical and experimental activity on the Shuttle Orbiter, first performed at NASA Langley within the OEX workshop and subsequently at ESA, as part of the AGARD FDP WG 18 activities. The study at Langley was undertaken to resolve the pitch up anomaly observed during the entry of the first flight of the Shuttle Orbiter. The facilities used at NASA Langley were the 15-in. Mach 6, the 20-in, Mach 6, the 31-in. Mach 10 and the 20-in. Mach 6 CF4 facility. The paper focuses on the high Mach, high altitude portion of the first entry of the Shuttle where the vehicle exhibited a nose-up pitching moment relative to pre-flight prediction of (Delta C(sub m)) = 0 03. In order to study the relative contribution of compressibility, viscous interaction and real gas effects on basic body pitching moment and flap efficiency, an experimental study was undertaken to examine the effects of Mach, Reynolds and ratio of specific heats at NASA. At high Mach, a decrease of gamma occurs in the shock layer due to high temperature effects. The primary effect of this lower specific heat ratio is a decrease of the pressure on the aft windward expansion surface of the Orbiter causing the nose-up pitching moment. Testing in the heavy gas, Mach 6 CF4 tunnel, gave a good simulation of high temperature effects.
Author
Space Shuttle Orbiters; Aerothermodynamics; Mach Number; European Space Agency; NASA Programs

19980033520 Wright Lab., FII, Wright-Patterson AFB, OH United States
THE USE OF TECHNOLOGY DEMONSTRATORS TO REDUCE SYSTEM ACQUISITION COST
Moorhouse, David J., Wright Lab., USA; Paul, Donald B., Wright Lab., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 12p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In the definition and design of a new aircraft system, the choice of technologies to be incorporated is a major decision. Although the latest technology usually yields the maximum (predicted) performance, the readiness of each technology must be carefully assessed. The less the readiness or maturity, the greater the risk to development schedule and cost. There is a premium therefore, on demonstrations that validate the appropriate maturity of each technology. For some things ground demonstration is adequate to reduce the risk to an acceptable level. Some technologies, on the other hand, can only be validated through flight demonstration. Technology flight demonstration programs have been accomplished in many forms, explicit prototype vehicles, the X-plane series from the X-1 to the X-31 and technology demonstrations with an explicit military objective.
Derived from text
Aircraft Design; Flight Tests; Cost Reduction; Prototypes; Costs

19980203988 Centre d'Etudes et de Recherches, Dept. of Aerothermodynamics, Toulouse, France
MEASUREMENT TECHNIQUES DEVELOPED FOR CRYOGENIC FIELD IN T2 TRANSONIC WIND TUNNEL
Seraudie, A., Centre d'Etudes et de Recherches, France; Archambaud, J. P., Centre d'Etudes et de Recherches, France; Mignosi, A., Centre d'Etudes et de Recherches, France; May 1998; 12p; In English; See also 19980203985; Original contains color illustrations; Copyright

Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

T2 is an induction driven wind tunnel in which Reynolds number variations are obtained by increasing the total pressure (P(sub t) = 1,4 to 3bar) and reducing the total temperature (T(sub t) = 300 to 110K). The flow is driven by an injection of dry air at ambient temperature and cooled by another injection of liquid nitrogen. Advanced development of conventional techniques and modern measurement techniques have been performed for low-temperature cryogenic flows. This paper presents the evolution of the specific tools sometimes developed, always tested and mainly used for different 2D or 3D flows at ambient and cryogenic conditions. Firstly, it gives the developments performed in the field of anemometer and pressure probes to measure the flow quality of the cryogenic wind tunnel. Secondly, it describes the use of an infrared technique for the qualification of the boundary layer transition on 2D and 3D models. Finally, this paper presents some L.D.A. typical 2D and 3D measurements at ambient condition and the adaptation of this velocity measurement device to work in cryogenic conditions.

Author

Mechanical Measurement; Cryogenic Wind Tunnels; Transonic Wind Tunnels; Infrared Imagery; Reynolds Number; Aerodynamic Coefficients; Aerodynamics

19980203989 Imperial Coll. of Science Technology and Medicine, Dept. of Aeronautics, London, United Kingdom

DEVELOPMENT OF PIV FOR TWO AND THREE COMPONENT VELOCITY MEASUREMENTS IN A LARGE LOW SPEED WIND TUNNEL

Bearman, P. W., Imperial Coll. of Science Technology and Medicine, UK; Harvey, J. K., Imperial Coll. of Science Technology and Medicine, UK; Stewart, J. N., Imperial Coll. of Science Technology and Medicine, UK; May 1998; 10p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The use of particle image velocimetry, PIV, to make measurements in flows generated around models in a low speed wind tunnel is described. The tunnel test section employed is 3m wide by 1.5m high. The problems associated with using PIV in air at large scale, and how they can be overcome, are discussed. Stereoscopic PIV is used to measure all three components of velocity in planes across a flow. Errors due to parallax that are present in velocity components measured in the plane of a light sheet when there is an accompanying flow through the sheet, are corrected. The flows studied are generated by a l/8th scale passenger car model and a l/8th scale model of an aircraft with a wing sweep of 70 degrees. It is found that a reasonable estimate of a mean flow field can be obtained by averaging as few as ten instantaneous spatial distributions of velocity.

Author

Particle Image Velocimetry; Low Speed Wind Tunnels; Velocity Measurement; Flow Measurement

19980206043 Universitaet der Bundeswehr, Lab. fuer Stroemungsmaschinen, Hamburg, Germany

A QUANTITATIVE 2D DENSITY MEASURING SYSTEM USING UV RAYLEIGH SCATTERING AT AN ATMOSPHERIC WIND TUNNEL

Jakiel, C., Universitaet der Bundeswehr, Germany; Fiedler, K., Universitaet der Bundeswehr, Germany; Sieber, O., Universitaet der Bundeswehr, Germany; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

An optical density measuring system based on Rayleigh scattering was installed in an atmospheric wind tunnel. The system monitors the scattered light induced by a laser sheet irradiating the flow field behind a plane VKI-1 turbine cascade. The measuring procedure needing very short time is based on a relative measurement. This paper presents a brief summary of fundamentals, the experimental setup, and the measurement principles. As experimental result plane density distributions at different blade heights are given for subsonic and transonic flow. The experimental data is compared to results of a three-dimensional Navier-Stokes calculation.

Author

Density Measurement; Rayleigh Scattering; Gas Jets; Cascade Flow; Optical Measuring Instruments; Turbines; Wind Tunnels

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ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see 91 Lunar and Planetary Exploration.

19970017949 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France

AEROSPACE 2020, VOLUME 1, SUMMARY *AERONAUTIQUE ET ESPACE A L'HORIZON 2020*

Apr. 1997; 48p; In English

Report No.(s): AGARD-AR-360-Vol-1; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

Volume 1, the summary volume, of the report of the NATO Advisory Group for Aerospace Research and Development (AGARD) study: 'Aerospace 2020'. This study explores the most advanced technologies, relevant to aerospace, being researched and developed in laboratories today. The study focuses on the most promising current technologies and the organizational and tactical consequences they will have at the field and system levels, over the course of the next 25 years. Topics include: a discussion of the impact of proliferation, human-machine interaction, synthetic environments, directed-energy weapons, information technologies, unmanned tactical aircraft, suborbital launchers, hypersonic missiles, and a discussion of affordability issues. Technologies are assessed from the viewpoints of both potential capabilities and threats. Observations and recommendations are presented.

Author

Aerospace Engineering; Weapon Systems; North Atlantic Treaty Organization (NATO); Man Machine Systems; Fighter Aircraft; Pilotless Aircraft; Hypersonics

19970026418 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France

SPACE SYSTEMS AS CONTRIBUTORS TO THE NATO DEFENCE MISSION *LES SYSTEMES SPATIAUX CONTRIBUANT A LA STRATEGIE DE DEFENSE DE L'OTAN*

Space Systems as Contributors to the NATO Defence Mission; Jun. 1997; 194p; In English; In French; 5th, 3-6 Jun. 1996, Cannes, France; See also 19970026419 through 19970026435; Original contains color illustrations

Report No.(s): AGARD-CP-580; ISBN 92-836-0041-X; Copyright Waived; Avail: CASI; A09, Hardcopy; A03, Microfiche

This volume contains the Technical Evaluation Report and the 19 unclassified papers, presented at the Mission Systems Panel Symposium. The papers presented cover the following headings: Invited Papers; Military Applications of Civil Systems; Communications (Systems); Communications (Technology); Surveillance (Reconnaissance); Surveillance (Meteorology); Surveillance (Early Warning); Information Extraction; Vehicle Management; Future Systems and Panel Discussion.

Author (revised)

Aerospace Systems; Military Technology; Reconnaissance; Surveillance; Telecommunication

19970026419 North Atlantic Treaty Organization, Communications and Information Systems Agency, Brussels, Belgium

THE EVOLVING NATO SATELLITE EXPERIENCE

Kelly, P. A., North Atlantic Treaty Organization, Belgium; Space Systems as Contributors to the NATO Defence Mission; Jun. 1997; 8p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

I am very pleased to have been asked to give the scene setting presentation on the NATO use or projected use of space. NATO has been in the satellite business since the mid 1960s. At this point however, I believe it would help if I was to stress that NATO's primary interest lies in the use of satellites for communications (SATCOM), although we have given consideration to the possible use of satellites for surveillance. Many of you may be aware of one of our latest require-

ments for battlefield intelligence information which will most probably be met through a new program entitled Alliance Ground Surveillance (AGS).
Derived from text
Communication Satellites; Surveillance; Intelligence

19990046232 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
AEROSPACE 2020, VOLUME 2 *AERONAUTIQUE ET ESPACE A L'HORIZON 2020, VOLUME II*
December 1998; 224p; In French
Report No.(s): AGARD-AR-360-Vol-2(F); ISBN 92-836-2002-X; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

Volume II, is the main document of the "Aerospace 2020" report by the NATO Advisory Group for Aerospace Research and Development (AGARD). This study examines the most advanced aerospace technologies currently under development or study. It centers on what are now considered to be the most promising technologies, as well as structural and tactical consequences they will have on the theater of operations and on systems over the next 25 years. Subjects covered include the impact of proliferation, man-machine interaction, synthetic environments, directed-energy armaments, information technology, unpiloted tactical aircraft, suborbital launchers, hypersonic missiles as well as a discussion of acceptable acquisition costs. The technologies are evaluated from two viewpoints: as assets and as threats. Remarks and recommendations are presented.
Transl. by Schreiber
Aerospace Engineering; North Atlantic Treaty Organization (NATO); Technology Assessment; Military Operations; Defense Program

14
GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

19960003884 Aerospatiale, Cannes, France
AEROSPATIALE SATELLITES (CANNES SITE) INTEGRATION AND TEST CENTER
Richard, Macario, Aerospatiale, France; Coroller, Jean-Francois, Aerospatiale, France; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 3 p; In English; See also 19960003881; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Since October 1993, AEROSPATIALE has used the following extended integration and test facilities: (1) a new large integration room; (2) a new space simulation chamber; and (3) a RF simulation chamber (compact range type). The aim of this presentation is to point out the technical characteristics of these new facilities and the advantages of the whole integration and test room center.
Derived from text
French Satellites; Systems Integration; Technology Utilization; Test Chambers; Test Facilities

19960003906 Dynacon Enterprises Ltd., Downsview Ontario, Canada
DEVELOPMENT OF A MODAL TESTING SUPPORT SYSTEM FOR SPACE-BASED RADAR SATELLITE STRUCTURES
Mctavish, D. J., Dynacon Enterprises Ltd., Canada; Sincarsin, G. B., Toronto Univ., Canada; Soucy, Y., Canadian Space Agency, Canada; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 12 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The development of a modal testing support system (MTSS) for the Canadian Department of National Defence (DND) is described. The MTSS consists of both hardware and software elements which will augment existing testing facilities of the Canadian Space Agency. A critical capability of the MTSS is the ability to deal methodically with structures so large and flexible that they are unable to properly support their own weight in a 1-g environment. The structures of the envisioned space-based radar (SBR) satellites fall into this class. The performance of such a surveillance system depends upon satisfactory structural dynamic response of the spacecraft, among other factors. The output of the modal testing process is an experimentally validated structural model which becomes a valuable tool for predicting dynamic behavior. to support the validation of this system, a number of test structures are being produced which will emulate the structural behavior of a generic SBR mechanical system.
Author
Canada; Dynamic Characteristics; Dynamic Response; Dynamic Tests; Ground Tests; Performance Prediction; Satellite-Borne Radar; Space Based Radar; Spacecraft Instruments; Support Systems; Test Facilities

19960003908 Centre National d'Etudes Spatiales, Toulouse, France
HYPERSONIC AERODYNAMIC/AEROTHEMAL TEST FACILITIES AVAILABLE IN EUROPE TO SUPPORT SPACE VEHICLE DESIGN
Vennemann, D., Centre National d'Etudes Spatiales, France; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 14 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The paper gives an overview of the major hypersonic windtunnels available in Europe for the determination of aerodynamic characteristics, like forces and moments, or for the measurement of heat transfer rates and heat transfer distributions of space vehicle configurations. The following facilities are presented: (1) the blow-down windtunnel S4 of ONERA at Modane, France; (2) the longshot facility of the Von Karman Institute at Rhode-Saint-Genese, Belgium; (3) the shock tunnel TH2 of the Aachen Technische Hochschule RWTH, Germany; (4) the piston-driven wind-tunnel HEG of DLR at Gottingen, Germany; and (5) the hot shot test facility F4 of ONERA at Le Fauga, France. The operating principle of each of these facilities is described, the performance characteristics are given, and the main features of their construction are high-lighted. This is followed by a short presentation of some advanced optical measurement techniques available for use in the facilities like the electron beam technique, the laser induced fluorescence (LIF) technique, the tunable laser diode, and holographic interferometry.
Derived from text
Aerodynamic Characteristics; Ground Tests; Hypersonic Wind Tunnels; Hypersonics; Shock Tunnels; Spacecraft Design; Test Facilities; Wind Tunnel Tests

15
LAUNCH VEHICLES AND SPACE VEHICLES

19950026707 Central Research Inst. of Technology and Machine Building, Kaliningrad, Moscow, Russia
THE CONCEPT OF THE SPACE SYSTEM BASED ON THE ROCKET LAUNCH VEHICLE OF LIGHT-WEIGHT CLASS FOR DIRECT SOUNDING OF LARGE-SCALE NATURAL HAZARDS
Loukiachtchenko, V. I., Central Research Inst. of Technology and Machine Building, Russia; Tsyboulskii, G. A., Central Research Inst. of Technology and Machine Building, Russia; Nedaivoda, A. K., Khrunichev State Research and Production Space Center, Russia; Karrask, V. K., Khrunichev State Research and Production Space Center, Russia; Medvedev, A. A., Khrunichev State Research and Production Space Center, Russia; Meliankov, N. A., Khrunichev State Research and Production Space Center, Russia; Philosophov, S. N., Khrunichev State Research and Production Space Center, Russia; Karmasin, V. P., Nauchno-Proizvodstvennoe Obedinenie Typhoon, Russia; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 8 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

The report contains the description of proposal on development and use of space system intended for direct (contact) exploration of such natural hazards as, for example, tropical cyclones or ozone hole which are heavy influences on human life activity. This system would be developed on base of Russian (former Soviet) SS-19 ICBM, which should be removed from battle duty according to the START Treaty. Recently developed on the basis that ICBM Russian 'Rockot' launch vehicle can deliver with high accuracy to hazard region up to 50 reentry probes which should transmit the information through space, airborne or sea retransmitters. That efficient collection of information on atmo-

sphere conditions in altitude range of 40...0 kilometers should be the effective tool for investigation of large-scale natural phenomena which are very dangerous for people and economics of Earth.
Derived from text
Environmental Laboratories; Feasibility Analysis; Hazards; Launch Vehicles; Technology Assessment; Technology Transfer

19960003900 Defence Research Agency, Spacecraft Environment and Protection Section., Farnborough, Hampshire, United Kingdom
TECHNOLOGY DEMONSTRATION EXPERIMENTS ON STRV-1
Wrenn, Gordon L., Defence Research Agency, UK; Sims, Andrew J., Defence Research Agency, UK; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 6 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Ariane 44LP/V64 was launched on 17 June 1994 when it placed two microsatellites, Space Technology Research Vehicle (STRV)-1a and STRV-1b, into geostationary transfer orbit (GTO). This paper describes the technology demonstration experiments on the spacecraft, with particular emphasis on the theoretical and empirical models used for design and testing, and presents some early data as evidence that the mission objectives will be met.
Author
Earth Orbits; Radiation Effects; Small Scientific Satellites; Spaceborne Experiments; Spacecraft Charging; Transfer Orbits

19970026434 Aerospace Corp., Los Angeles, CA United States
MULTI-LAUNCH VEHICLE INTEGRATION ISSUES FOR MILITARY SATELLITES
Yahner, Jack A., Aerospace Corp., USA; Deabler, Gregory A., Air Force Systems Command, USA; Jun. 1997; 10p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Most satellites are designed to optimize their operability in space; optimizing their ability to arrive in space is secondary. Regardless of bow well a satellite system is produced it cannot have the opportunity to operate if the launch vehicle it was designed for is unavailable. Access to space can be optimized by providing launch vehicles with a 'fitness for use' approach. The ability to launch a satellite on different launch vehicles with minimal or no modifications to either the satellite or the launch vehicle is highly desirable in both the defense and emerging commercial markets.
Derived from text
Military Spacecraft; Launching; Military Operations; Satellites

19970029358 Instituto Nacional de Tecnica Aeroespacial, Torrejon de Ardoz, Spain
CAPRICORNIO LAUNCHER: AN APPROACH TO A MODULAR AND LOW COST SOFTWARE ARCHITECTURAL DESIGN
Gallego, Jose M., Instituto Nacional de Tecnica Aeroespacial, Spain; Rico, Jose E., Instituto Nacional de Tecnica Aeroespacial, Spain; Jul. 1997; 10p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper introduces the Capricornio Program by means of describing the vehicle requirements, architecture and guidance philosophy as well as the required ground facilities. Later and in a more detailed way, Requirements Specifications and TopLevel Design of CAPRICORNIO Launcher Software are presented, with a reference to the static and dynamic behavior of the chosen architecture. Hardware interaction aspects are omitted. Regarding the Ground Control Computer Software, an overview of the Rapid Prototyping Technique through Lab VIEW is presented with a look to the first results. This article shows how a low cost software is being developed with a high modularity and flexibility degree allowing an easy migration among demonstrator vehicles (ARGO) and finally, the CAPRICORNIO launcher.
Author
Ground Based Control; Software Engineering; Modularity; Launchers; Dynamic Characteristics; Computer Systems Programs

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SPACE TRANSPORTATION

19960003903 Deutsche Aerospace A.G., Munich, Germany
FLIGHT TESTING VEHICLES FOR VERIFICATION AND VALIDATION OF HYPERSONICS TECHNOLOGY
Sacher, Peter W., Deutsche Aerospace A.G., Germany; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 13 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Hypersonics technology has obtained renewed interest since various concepts for future completely reusable Space Transportation Systems (STS) using airbreathing propulsion for the parts of atmospheric flight have been proposed in different countries (e.g. US, CIS, Japan, France, Germany, and UK). to cover major developments in those countries, AGARD FDP has formed the Working Group 18 on 'Hypersonic Experimental and Computational Capabilities - Improvement and Validation'. of major importance for the proof of feasibility for all these concepts is the definition of an overall convincing philosophy for a 'hypersonics technology development and verification concept' using ground simulation facilities (both experimental and numerical) and flight testing vehicles. Flying at hypersonic Mach numbers using airbreathing propulsion requires highly sophisticated design tools to provide reliable prediction of thrust minus aerodynamic drag to accelerate the vehicle during ascent. Using these design tools, existing uncertainties have to be minimized by a carefully performed code validation process. to a large degree the database required for this validation cannot be obtained on ground. In addition thermal loads due to hypersonic flow have to be predicted accurately by aerothermodynamic flow codes to provide the inputs needed to decide on materials and structures. Heat management for hypersonic flight vehicles is one of the key-issues for any kind of successful flight demonstration. This paper identifies and discusses the role of flight testing during the verification and validation process of advanced hypersonic technology needed for flight in the atmosphere with hypersonic Mach numbers using airbreathing propulsion systems both for weapons and space transportation systems.
Derived from text
Air Breathing Engines; Flight Test Vehicles; Flight Tests; Hypersonic Flight; Hypersonic Vehicles

19970026433 Aerospace Corp., El Segundo, CA United States
FUTURE SPACE TRANSPORTATION SYSTEMS AND THEIR POTENTIAL CONTRIBUTION TO THE NATO MISSION
Whitehair, Chester L., Aerospace Corp., USA; Wolfe, Malcolm G., Aerospace Corp., USA; Jun. 1997; 12p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Space systems are now an essential part of military operations and, in the Western World, the reliability and operability of these systems is crucial to the success of the military mission. At the same time, overall western military budgets universally are suffering severe cuts. Although the Cold War is over, the threat to world peace, if anything, has increased rather than decreased. The threat is also much more difficult to contain. The well-defined, single-source, monolithic threat of the Cold War has been replaced by a multi-source, distributed threat. The questions arise - how has the NATO peacekeeping or warfighting mission changed in response to the new world environment; are the space resources of the Cold War the ones that can be effective in the future; how can dwindling government military budgets be augmented by the use of internationally shared or commercial space assets; and how can emerging space technologies and capabilities, whether developed by the government or the commercial sector, contribute to world peace?
Derived from text
Space Transportation System; Aerospace Engineering; Aerospace Systems; Military Operations

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SPACE COMMUNICATIONS, SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING

19950023204 Army Medical Command (18th)., Unit 15281.; **USA**
REQUIREMENT FOR ONBOARD TELEMETRY EQUIPMENT
Granger, Mathew S., Army Medical Command (18th)., USA; Urbauer, Craig L., Army Medical Command (18th)., USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 5 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The use of onboard telemetry equipment in EMS ground and air ambulances has made significant inroads in the civilian sector. This article reviews data from 661 patients evacuated by UH-60A helicopters in the Republic of Korea from June 1993 through May 1994. Patient categories, enroute care provided, and patient outcomes are analyzed to determine if onboard telemetry equipment would have improved enroute care provided or patient outcome. The data indicates onboard telemetry would have been of marginal utility and would not have affected patient outcomes. It is the conclusion of the authors that onboard telemetry equipment would be of limited value in military aeromedical evacuation operations.
Author
Air Transportation; Evacuating (Transportation); Medical Equipment; Medical Services; Onboard Equipment; Telemetry

19950026723 MATRA Marconi Space, Toulouse, France
GPS-BASED NAVIGATION FOR SPACE APPLICATIONS
Champetier, C., MATRA Marconi Space, France; Duhamel, T., MATRA Marconi Space, France; Frezet, M., MATRA Marconi Space, France; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 9 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

We present in this paper a survey of the applications of the GPS (global positioning system) system for spacecraft navigation. The use of the GPS techniques for space missions is a striking example of dual-use of military technology; it can bring vast improvements in performances and, in some cases, for a reduced cost. We only deal in this paper with the functional aspects and performances of GPS uses without addressing the issues of hardware implementation where current developments are leading to an increased miniaturization of the GPS receiver hardware. We start this paper with a general overview of the GPS system and its various uses for space missions. We then focus on four areas where MATRA MARCONI Space has conducted detailed analyses of performances: autonomous navigation for geostationary spacecraft, relative navigation for space rendezvous, differential navigation for landing vehicles, absolute navigation for launchers and reentry vehicles.
Derived from text
Autonomous Navigation; General Overviews; Global Positioning System; Military Technology; Space Missions; Space Navigation; Technology Utilization

19960003400 New Brunswick Univ., Geodetic Research Lab., Fredericton New Brunswick, Canada
SATELLITE NAVIGATION
Langley, Richard B., New Brunswick Univ., Canada; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 158-176; In English; See also 19960003395; Submitted for publication to GPS World Magazine and to Guide to GPS Positioning; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Satellite navigation provides unprecedented accuracy and world wide coverage to aerospace vehicle. This section reviews in some detail the NAVSTAR Global Position System (GPS) followed by a survey of other satellite navigation systems.
Author
Navstar Satellites; Radio Receivers; Satellite Communication; Satellite Navigation Systems; Space Navigation; Technology Assessment

19960003412 Draper (Charles Stark) Lab., Inc., Cambridge, MA, United States
SPACECRAFT NAVIGATION REQUIREMENTS
Miller, Judy L., Draper (Charles Stark) Lab., Inc., USA; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 390-405; In English; See also 19960003395
Contract(s)/Grant(s): SDIO84-88-C-0009; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Spacecraft operation depends upon knowledge of vehicular position and, consequently, navigational support has been required for all such systems. Technical requirements for different mission trajectories and orbits are addressed with consideration given to the various tradeoffs which may need to be considered. The broad spectrum of spacecraft are considered with emphasis upon those of greater military significance (i.e., near earth orbiting satellites). Technical requirements include, but are not limited to, accuracy; physical characteristics such as weight and volume; support requirements such as electrical power and ground support; and system integrity. Generic navigation suites for spacecraft applications are described. It is shown that operational spacecraft rely primarily upon ground-based tracking and computational centers with little or no navigational function allocated to the vehicle, while technology development efforts have been and continue to be directed primarily toward onboard navigation suites. The military significance of onboard navigators is shown to both improve spacecraft survivability and performance (accuracy).
Author
Earth Orbits; Navigation Aids; Navigators; Onboard Equipment; Space Navigation; Spacecraft Trajectories; Support Systems; Technology Assessment; Technology Utilization

19960012294 MATRA Marconi Space, Toulouse, France
KNOWLEDGE-BASED SYSTEMS APPLICATIONS FOR AUTOMATING SPACECRAFT OPERATIONS: USERS FEEDBACK AND LESSONS LEARNED
Darroy, Jean-Michel, MATRA Marconi Space, France; Desaintvincent, Arnaud, MATRA Marconi Space, France; Lecouat, Francois, MATRA Marconi Space, France; AGARD, Knowledge-Based Functions in Aerospace Systems; Nov 1, 1995, 13 p; In English; See also 19960012290; Avail: CASI; A03, Hardcopy; A02, Microfiche

The first section of this paper outlines a baseline structure for knowledge-based guidance and control functions in the context of space missions. Guidance and control functions will be referred to here as 'Spacecraft Mission Operations', i.e., all the functions required to implement space missions. The development of a general baseline structure is difficult since these functions may vary considerably from manned space mission to unmanned mission, or from an earth observation satellite mission to a communications satellite mission. This section focuses on unmanned missions since they correspond to a majority of the actual space missions, and it presents a generic structure that is applicable to any kind of unmanned mission. Adaptation of this structure to manned space missions (e.g. Space Shuttles, Space Stations) is also discussed. The remaining section include 'New Challenges for Spacecraft Operations and KBS (Knowledge Based Systems) Applications', 'Procedures Preparation', 'Plan Generation', 'Operations Automation', 'Lessons Learned from the Deployment of OPSWARE(tm) Applications', and 'Major Stakes for the Coming Decade and Conclusions.'
Derived from text
Applications Programs (Computers); Knowledge Based Systems; Mission Planning; Space Missions; Spacecraft Control; Spacecraft Guidance

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SPACECRAFT DESIGN, TESTING AND PERFORMANCE

19960003881 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
SPACE SYSTEMS DESIGN AND DEVELOPMENT TESTING *LES ESSAIS DANS LA CONCEPTION ET LE DEVELOPPEMENT DES SYSTEMES SPATIAUX*
Mar 1, 1995; 309p; In English; In French; Flight Vehicle Integration Panel Symposium, 3-6 Oct. 1994, Cannes, France; See also

19960003882 through 19960003909
Report No.(s): AGARD-CP-561; ISBN 92-836-0014-2; Copyright Waived; Avail: CASI; A14, Hardcopy; A03, Microfiche

In view of the importance of space capability to the fulfillment of future NATO requirements, the Flight Vehicle Integration Panel of AGARD has placed increased emphasis on space technology. The goal of the symposium reported in this document was to permit information exchange and discussion on the test aspects of space systems design and development with the emphasis on systems related to anticipated future capabilities and the importance of adequate testing, and continued with six sessions comprising 28 technical papers in all. These sessions focused on: Testing Requirements and Practices; Flight Dynamics and Flexible/Deployable Structures; Systems Development and Evaluation; Simulation; Space Flight Experiments; and Test Facilities and Support.
Aerospace Engineering; Aerospace Systems; Conferences; North Atlantic Treaty Organization (NATO); Space Flight; Spacecraft; Spacecraft Design; Systems Engineering; Tests

19960003882 Aerospace Corp., Los Angeles, CA, United States
AN OVERVIEW OF DOD TEST REQUIREMENTS FOR LAUNCH AND SPACE SYSTEMS
Moening, Charles J., Aerospace Corp., USA; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 8 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

MIL-STD-1540 Test Requirements For Space Vehicles was first issued in 1974. This Military Standard prepared by The Aerospace Corporation for the USA Air Force space programs has been a reference for defining test programs for most U.S. DOD space systems. The third revision, to be MIL-STD-1540C, was prepared over the last two years with a primary objective of including test requirements for launch vehicles and upper stages. This paper discusses the background and effectiveness in using earlier revisions of the Standard and summarizes the major changes incorporated in MIL-STD-1540C 'Test Requirements for Launch, Upper Stages and Space Vehicles.'
Author
Aerospace Systems; Military Operations; Procedures; Spacecraft Launching; Specifications; Tests

19960003887 Lockheed Missiles and Space Co., Space Systems Div., Sunnyvale, CA, United States
SPACECRAFT DEPLOYABLE STRUCTURE TESTING
Dotson, Ronald D., Lockheed Missiles and Space Co., USA; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 12 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes test programs that develop and qualify spacecraft deployable structures. Spacecraft deployable structures (examples are solar arrays, antennas and booms) are typically a combination of moving mechanical assemblies (examples are joints, latches and gimbals) and structural elements. Moving mechanical assemblies contain numerous potential sources of nonlinearities, such as freeplay, friction and hysteresis in joints and sliding surfaces. Also, larger deployables have low natural frequencies when deployed and may have large area to weight ratios. These subsystems can be significantly affected by gravity, air, humidity and other 'ground based effects'. This paper discusses how to address the concerns for deployable structures testing when simulating the desired environments and demonstrating functionality.
Author
Deployment; Friction; Gravitation; Hysteresis; Spacecraft Structures; Structural Analysis; Tests

19960003888 Brussels Univ., Dept. of Mechanical Engineering and Robotics.; **Belgium**
ACTIVE STRUCTURES FOR VIBRATION SUPPRESSION AND PRECISION POINTING
Preumont, Andre, Brussels Univ., Belgium; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 10 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper describes the work performed at ULB for the development of active structures for space applications, using the piezoelectric technology. The control strategy involves two embedded control loops. The inner loop consists of a decentralized active damping using colocated actuator-sensor pairs and control schemes with guaranteed stability properties. The outer loop consists of a pointing or position control using non-colocated actuators and sensors. Two examples of active damping are presented: a truss with linear actuators and a plate with piezo strips. Next, a position control is developed for the truss. The control law is derived from the frequency-shaped LQG methodology, using a simplified model of the actively damped structure; the bandwidth of the control system includes the first two flexible modes of the structure. It is demonstrated that the active damping improves substantially the performance and the robustness of the position control loop, inside and outside its bandwidth.
Author
Active Control; Actuators; Control Theory; Piezoelectricity; Pointing Control Systems; Structural Stability; Structural Vibration; Vibration Damping

19960003889 Canadian Astronautics Ltd., Ottawa Ontario, Canada
STRUCTURAL VERIFICATION OF THE SPACE STATION FREEDOM FORCE MOMENT SENSOR (FMS) USING FINITE ELEMENT MODELLING TECHNIQUES AND QUALIFICATION TESTING
Christie, B., Canadian Astronautics Ltd., Canada; Mackay, B., Canadian Astronautics Ltd., Canada; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 11 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The design and development of the Canadian Force Moment Sensor (FMS) for use on the Space Station Remote Manipulator System (SSRMS) involved structural verification of strength, stiffness and life capabilities. The FMS, which is comprised of a primary structure - the sensor ring unit (SRU) and an electronics unit (EU), is used to detect on-orbit, operational forces and moments by measuring strain across six complexly shaped flexural members (struts). To achieve the required sensitivity, the struts must maintain a relatively high degree of flexibility which makes them more susceptible to the severe, repetitive loading environments experienced during the launch and on-orbit phases. The structural verification of the FMS system was demonstrated by structural analyses and qualification testing. The structural analyses included detailed finite element modelling of the FMS-SRU which examined strength margins, stiffness characteristics and fracture susceptibility. The Qualification Test Program supported the finite element modelling and included strength and stiffness testing using special test equipment (STE) in addition to the standard environmental tests. This paper describes the mathematical modelling and testing which was used to verify the structural performance of the FMS, and the techniques used in correlating test results with the predictions.
Author
Design Analysis; Finite Element Method; Launching; Mathematical Models; Remote Manipulator System; Space Station Freedom; Structural Analysis

19960003890 MATRA Marconi Space, Toulouse, France
MASTERING THE EFFECT OF MICROVIBRATIONS ON THE PERFORMANCES OF RECONNAISSANCE SATELLITES
Monteil, D., MATRA Marconi Space, France; Guillaud, V., MATRA Marconi Space, France; Laurens, PH., MATRA Marconi Space, France; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 11 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The development of very high resolution observation satellites has led to microdynamic problems. The quality of the images produced by reconnaissance satellites implies that they observe stringent line-of-sight stability requirements. The aims of this paper are to present the methodologies used at MATRA MARCONI SPACE (MMS) and to show the importance of tests in the prediction and verification logic. In the first part, stability requirements for reconnaissance satellites are reviewed. Constraints issued from new signal processing technologies are presented. In the second part, microvibration sources, their propagation throughout the satellite and their effects on the line-of-sight (LOS) are detailed. The prediction and verification logic is described in the third part. It is based on an intimate combination of analyses and tests at equipment, subsystem and satellite levels: the proposed approach for microdynamics is similar to thermal and mechanical processes using hierarchical specifications, tests, analyses, and interface control documents. Finally, several examples of

microdynamic tests performed at MMS on reconnaissance satellites are presented to illustrate their major contributions to high frequency pointing requirements demonstration.
Derived from text
Dynamic Stability; Image Resolution; Satellite Imagery; Satellite Observation; Structural Stability; Structural Vibration; Vibration Damping

19960003891 NASA Langley Research Center, Hampton, VA, United States
AEROTHERMODYNAMIC TESTING REQUIREMENTS FOR FUTURE SPACE TRANSPORTATION SYSTEMS
Paulson, John W., Jr., NASA Langley Research Center, USA; Miller, Charles G., III, NASA Langley Research Center, USA; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 22 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Aerothermodynamics, encompassing aerodynamics, aeroheating, and fluid dynamic and physical processes, is the genesis for the design and development of advanced space transportation vehicles. It provides crucial information to other disciplines involved in the development process such as structures, materials, propulsion, and avionics. Sources of aerothermodynamic information include ground-based facilities, computational fluid dynamic (CFD) and engineering computer codes, and flight experiments. Utilization of this triad is required to provide the optimum requirements while reducing undue design conservatism, risk, and cost. This paper discusses the role of ground-based facilities in the design of future space transportation system concepts. Testing methodology is addressed, including the iterative approach often required for the assessment and optimization of configurations from an aerothermodynamic perspective. The influence of vehicle shape and the transition from parametric studies for optimization to benchmark studies for final design and establishment of the flight data book is discussed. Future aerothermodynamic testing requirements including the need for new facilities are also presented.
Author
Aerothermodynamics; Ground Stations; Research Facilities; Space Transportation System; Spacecraft Design; Test Facilities

19960003892 McDonnell-Douglas Aerospace, Huntington Beach, CA, United States
TEST ASPECT OF SINGLE STAGE TO ORBIT SYSTEMS
Gaubatz, William A., McDonnell-Douglas Aerospace, USA; Nowlan, Daniel R., McDonnell-Douglas Aerospace, USA; Maras, Mathew G., McDonnell-Douglas Aerospace, USA; Copper, John A., McDonnell-Douglas Aerospace, USA; Coleman, Kate A., Coleman Science and Research, USA; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 7 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The McDonnell Douglas Delta Clipper Team recently completed the initial flight testing of a one third scale version of an operational single stage to orbit vehicle. The Delta Clipper Experimental, DC-X, is a 14 m tall, totally reusable, liquid hydrogen/liquid oxygen fueled test vehicle powered by four P&W RL-IOAS rocket engines. It has totally autonomous on board flight control and mission control systems; flight test mission requirements are simply added through software to the mission controller. The DC X is designed to explore and validate the low speed flight qualities of a vertical take-off and vertical landing spacecraft and its flight characteristics closely duplicate those predicted for the full scale DC-1 vehicle. The DC-1 vehicle would be capable of routinely flying people and/or cargo to and from space and would have a lift capacity for carrying 12 metric tons to low earth orbit.
Derived from text
Automatic Control; Controllers; Delta Clipper; Flight Control; Flight Tests; Test Vehicles

19960003893 Defence Research Agency, Farnborough, Hampshire, United Kingdom
FADS: A DEMONSTRATOR FOR MILCOMSAT AOCS
Huddleston, Martin, Defence Research Agency, UK; Cope, Paul, MATRA Marconi Space Portsmouth, UK; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 7 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This project covers the attitude and orbit control systems (AOCS) research program being carried out as part of the MOD applied research program for AD CIS(OR)1. The project program is to evaluate the candidate sensor technologies and control algorithms, such as Kalman filters, which may be applied to future UK military ComSats. The specific needs of military satellites for robust and threat-resistant control are not offered by current civil technologies which normally use vulnerable earth sensors or RF pointing which is vulnerable to deception. The program is also to investigate ways of reducing control system complexity and improvements in attitude control precision by enabling structural modes to be controlled. The project examines the most promising attitude control system technologies required to support such future communications payloads. User requirements indicate a need for improved threat resistance and for narrower spot beams, and the program supports this perceived need by the use of improved sensors and control algorithms. Improved pointing on civil ComSats is normally by means of ground RF measurements to form a closed loop control system with the spacecraft. For threat reasons this method is unsuitable for military ComSats, and on-board sensors are therefore used. The use of Silicon array star or earth sensors are the most promising, and the sensor program is to concentrate on these. Limited development and available civil sensors will be considered. Experimental work is based on demonstrating and evaluating real hardware in-the-loop on an existing air bearing experimental rig. This offers the closest simulation of real flight performance that can be obtained. The program will develop the Filtered Attitude Determination System (FADS)rig to be fully representative of a MilSatCom satellite, threat-resistant AOCS solution, employing Silicon array star and earth sensors. Both the BAe Mosaic Earth Sensor (MES) nad Marconi Versatile Star Sensor (VSS) technologies show considerable potential as attitude sensors. The VSS and MES capabilities will be evalutated on the FADS rig.
Derived from text
Algorithms; Communication Satellites; Flight Simulation; Guidance Sensors; Reconnaissance Spacecraft; Satellite Attitude Control; Star Trackers

19960003894 NASA Ames Research Center, Moffett Field, CA, United States
PEGASUS AIR-LAUNCHED SPACE BOOSTER FLIGHT TEST PROGRAM
Elias, Antonio L., Orbital Sciences Corp., USA; Knutson, Martin A., NASA Ames Research Center, USA; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 9 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Pegasus is a satellite-launching space rocket dropped from a B52 carrier aircraft instead of launching vertically from a ground pad. Its three-year, privately-funded accelerated development was carried out under a demanding design-to-nonrecurring cost methodology, which imposed unique requirements on its flight test program, such as the decision not to drop an inert model from the carrier aircraft; the number and type of captive and free-flight tests; the extent of envelope exploration; and the decision to combine test and operational orbital flights. The authors believe that Pegasus may be the first vehicle where constraints in the number and type of flight tests to be carried out actually influenced the design of the vehicle. During the period November 1989 to February of 1990 a total of three captive flight tests were conducted, starting with a flutter clearing flight and culminating in a complete drop rehearsal. Starting on April 5, 1990, two combination test/operational flights were conducted. A unique aspect of the program was the degree of involvement of flight test personnel in the early design of the vehicle and, conversely, of the design team in flight testing and early flight operations. Various lessons learned as a result of this process are discussed throughout this paper.
Author
Air Launching; Flight Operations; Flight Tests; Pegasus Air-Launched Booster; Spacecraft Launching

19960003897 Universidad Politecnica de Madrid, Madrid, Spain
USE OF SIMULATION TOOLS AND FACILITIES FOR RENDEZVOUS AND DOCKING MISSIONS
Serrano-Martinez, J. B., Universidad Politecnica de Madrid, Spain; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 12 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper presents a methodology for the use of simulation tools and facilities for the different phases of a Rendezvous Docking (RVD)

project. The methodology is developed trying to minimize development risks and planning shifts. Emphasis is placed on the elements which are unique on the RVD systems, namely, the Guidance, Navigation and Control subsystem, the on-board operations and the docking mechanism assembly. Such a methodology is based on the reuse of existing simulation tools and facilities in Europe. The Automatic Rendezvous Capture Demonstration Mission (ARC) is taken as example RVD project. The rationale of the proposed methodology presented including: the role of simulators during the different phases of the RVD project (namely, development, verification, execution, and post flight phases), the identification of simulation requirements derived from the foreseen application and the particularities of the RVD systems, the review of existing simulation tools and facilities in Europe and the analysis of their applicability for the ARC project including identification and analysis of the required upgrades and adaptations on the reused simulators and the required characteristics of the non-existing simulators.
Author
Airborne/Spaceborne Computers; Computerized Simulation; Simulators; Space Rendezvous; Spacecraft Docking; Unmanned Spacecraft

19960003898 National Aerospace Lab., Amsterdam, Netherlands
SPACECRAFT ATTITUDE AND ORBIT CONTROL SYSTEMS TESTING
Sonnenschein, F. J., National Aerospace Lab., Netherlands; Schoomade, M., National Aerospace Lab., Netherlands; Zwartbol, T., National Aerospace Lab., Netherlands; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 9 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Contemporary AOCS are equipped with local Attitude Control Computers which provide sophisticated Attitude and Orbit Control functions, automatic Failure Detection and Isolation functions and extensive Telemetry and Telecommand handling functions. Generic models of the design, development and test life cycle approaches for such intelligent AOCS are emerging. Also knowledge of the activities to be performed and the generic design, development and test environments to be used during the different phases is accumulating. Lessons learned can be used to improve AOCS development life cycle approaches and to define new development and test environments which improve the efficiency of the design, development and test life cycle and quality of the product. The SAX (Satellite per Astronomia a raggi X) satellite is equipped with a contemporary AOCS providing the above mentioned functions. In this paper the SAX AOCS software design, development and test life cycle is described as an example of AOCS software development. Lessons learned and suggestions for possible improvements are given.
Derived from text
Astronomical Satellites; Computer Systems Design; Onboard Data Processing; Performance Tests; Satellite Attitude Control; Spacecraft Orbits; Systems Simulation

19960003899 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, United States
NASA TECHNOLOGY FLIGHT EXPERIMENTS PROGRAM
Pruscha, Stephen L., Jet Propulsion Lab., California Inst. of Tech., USA; Levine, Jack, NASA Washington, USA; Russo, Samuel C., Hughes Aircraft Co., USA; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 9 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

In addition to its scientific and life sciences experimental programs, NASA conducts flight experiments directed at development of space systems technologies. The experiments are conducted to obtain research data, to evaluate the performance or operation of experimental hardware in the space environment, or to validate components, subsystems, or systems prior to application in future spacecraft or missions. The requirements for specific technology experiments, and the priority assigned to them, vary significantly depending on the maturity of the technology. Some of the flight experiments address technologies still in the early research stage, while others are conducted to validate technology at relatively advanced levels of maturity. This paper discusses the overall technology flight experiments program and reports in some detail on four current or recently flown experiments ranging from research to technology validation at the system prototype level.
Author
Aerospace Environments; Aerospace Systems; Data Bases; Flight Tests; Research; Spaceborne Experiments; Spacecraft Design; Technology Assessment

19960003901 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, United States
US IN-SPACE ELECTRIC PROPULSION EXPERIMENTS
Stocky, John F., Jet Propulsion Lab., California Inst. of Tech., USA; Vondra, Robert, Phillips Lab., USA; Sutton, Alan M., Phillips Lab., USA; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 15 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Arcjet and ion propulsion offer potentially significant reductions in the mass of propulsion systems required for Earth orbiting satellites and planetary spacecraft. For this reason, they have been the subject of validation and demonstration programs. After examining the benefits of electric propulsion, this paper discusses the technology base for the Electric Propulsion Space Experiment (ESEX) arcjet demonstration experiment and the NASA Technology Application Readiness (NSTAR) ion propulsion validation program. As part of the Advanced Research Global Observation Spacecraft (ARGOS), ESEX will perform ten 15-min firings of a 30-kW ammonia arcjet. NASA's validation program, NSTAR, consists of two major elements: a ground-test element and an in-space experiment. The ground element will validate the life, integrability, and performance of low-power ion propulsion. The in-space element will demonstrate the feasibility of integrating and flying an ion propulsion system. The experiment will measure the interactions among the ion propulsion system, the host spacecraft, and the surrounding space plasma. It will provide a quantitative assessment of the ability of ground testing to replicate the in-space performance ion thrusters. by involving industry in NSTAR, a commercial source for this technology will be ensured. Furthermore, the successful completion of the NSTAR validation program will stimulate commercial and government (both civilian and military) uses of this technology.
Author
Arc Jet Engines; Electric Propulsion; Engine Tests; Ion Engines; Ion Propulsion; Spaceborne Experiments

19960003902 NASA Langley Research Center, Hampton, VA, United States
SHUTTLE ORBITER EXPERIMENTS: USE OF AN OPERATIONAL VEHICLE FOR ADVANCEMENT AND VALIDATION OF SPACE SYSTEMS DESIGN TECHNOLOGIES
Holloway, Paul F., NASA Langley Research Center, USA; Throckmorton, David A., NASA Langley Research Center, USA; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 17 p; In English; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The NASA Orbiter Experiments (OEX) Program provided a mechanism for utilization of an operational space shuttle orbiter as a flight research vehicle, as an adjunct to its normal space transportation mission. OEX Program experiments were unique among orbiter payloads, as the research instrumentation for these experiments were carried as integral parts of the vehicle's structure, rather than being placed in the orbiter's payload bay as mission-unique cargo. On each of its first 17 flights, the Orbiter Columbia carried some type of research instrumentation. Various instrumentation systems were used to measure, in flight, the requisite parameters for determination of the orbiter aerodynamic characteristics over the entire entry flight regime and/or the aerodynamic-heating rates imposed upon the vehicle during the hypersonic portion of atmospheric entry. The data derived from this instrumentation represent benchmark hypersonic flight data heretofore unavailable for a lifting entry vehicle. The data are being used in a continual process of validation of state-of-the-art methods, both experimental and computational, for simulating/predicting the aerodynamic and aerothermal characteristics of advanced space transportation vehicles. This paper describes the OEX Program complement of research experiments, presents typical flight data obtained by these experiments, and demonstrates the utilization of these data for advancement and validation of vehicle aerothermodynamic-design tools. By example, the concept of instrumenting opera-

tional vehicles and/or spacecraft in order to perform advanced technology development and validation is demonstrated to be an effective and economical method for maturing space-systems design technologies.
Author
Aerodynamic Characteristics; Air Data Systems; Data Acquisition; Flight Characteristics; Hypersonic Reentry; Space Shuttle Orbiters; Spacecraft Reentry

19960003904 European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands
EXTENSION OF THE ESA TEST CENTRE WITH HYDRA: A NEW TOOL FOR MECHANICAL TESTING
Brinkmann, Peter W., European Space Agency. European Space Research and Technology Center, Netherlands; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 10 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The introduction outlines the verification concept for programs of the European Space Agency (ESA). The role of the agency in coordinating the activities of major European space test centers is summarized. Major test facilities of the environmental test center at ESTEC, the Space Research and Technology Centre of ESA, are shown and their specific characteristics are highlighted with special emphasis on the six-degree-of-freedom (6-DOF) hydraulic shaker. The specified performance characteristics for sine and transient tests are presented. Results of single-axis hardware tests and 6-DOF computer simulations are included.
Author
Electromagnetic Compatibility; Environmental Tests; European Space Agency; Prelaunch Tests; Space Simulators; Test Facilities; Vibration Simulators; Vibration Tests

19960003907 Institut Superieur des Affaires, Jouy-en-Josas, France
A PRELIMINARY STUDY OF THE AIR DATA SENSING PROBLEM ON A RE-ENTRY VEHICLE
Hettena, E., Institut Superieur des Affaires, France; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 8 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A brief review of different measurement techniques for speed, pressure, and temperature on a re-entry vehicle is given in order to evaluate their applicability and limitations to the design of an air data system. A pressure-sensors based air data system is then assumed and an engineering aerodynamic model is used to investigate the influence of the measurement errors on the relevant air data parameters necessary for light guidance and control.
Author
Aerodynamic Characteristics; Air Data Systems; Flight Characteristics; Reentry Vehicles

19960003909 Centre d'Etudes et de Recherches, Dept. of Space Technology., Toulouse, France
GROUND TESTING AND SIMULATION ASSESSMENT OF SPACE ENVIRONMENT HAZARDS
Romero, Manola, Centre d'Etudes et de Recherches, France; Bourrieau, Jacques, Centre d'Etudes et de Recherches, France; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 7 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

For military and civilian needs, satellites are becoming more and more autonomous, smart (i.e., including big integration devices) and capable (i.e. processing large quantities of broad bandwith data). The technologies use to achieve such goals are sensitive to both noise an steady-state damage produced by the space environment. The purpose of this presentation is to describe some aspects of the problem, aiming at predicting overall system behavior in space. Indeed such a ground check of environmental hardness can be a daunting task considering the complexity of the space threat and the understandable reflectance of project managers to subject all or large portions of their systems to extensive possibly destructive testing.
Derived from text
Aerospace Environments; Artificial Satellites; Flight Simulation; Ground Tests; Hazards; Military Spacecraft; Technology Assessment

19970026369 Fluid Gravity Engineering Ltd., Liphook, United Kingdom
ENTRY AND VEHICLE DESIGN CONSIDERATIONS
Smith, Arthur, Fluid Gravity Engineering Ltd., UK; May 1995; 24p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In session 4 we shall look at basic equations of motion of a capsule during its approach and entry and note some relationships between trajectory, vehicle parameters and structural and thermal loads in order to investigate which vehicle characteristics are important in capsule aerothermodynamic design. Typical entry scenarios are explained including orbital transfer, aerobraking, and aerocapture. Design considerations for a ballistic capsules are explored with reference to Mars, Titan and Earth return, while a lifting capsule trade-off is considered for Earth return.
Author
Spacecraft Design; Atmospheric Entry; Reentry Vehicles; Aerothermodynamics; Aerodynamic Heating; Equations of Motion; Aerobraking; Aerocapture; Transfer Orbits

19970026378 NASA, Washington, DC United States
AEROASSIST KEY TO RETURNING FROM SPACE AND THE CASE FOR AFE
Williams, Louis J., NASA, USA; Putnam, Terrill W., NASA, USA; Morris, Robert, NASA Marshall Space Flight Center, USA; May 1995; 32p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Aeroassist Flight Experiment (AFE) is important in the development of a substantial and cost-competitive space industry. It is a research program to develop the technology base needed to design a new class of advanced entry vehicles that will play a key role in establishing a mature U.S. space presence in the next century. A dynamic and economical space program in the 21st century will include many operations involving the return of satellites, materials, and products from high Earth orbits (HEO), lunar bases, and planetary missions. The common and dominant characteristics of vehicles returning from such missions will be their very high speed as they approach the Earth. This high speed must be reduced substantially before the returning vehicle can be landed safely on Earth or placed in low Earth orbit (LEO), where the Space Shuttle operates now and the Space Station Freedom will operate in the future. LEO is a strategic that will always play a critical role in any space program. Its location just beyond earth's appreciable atmosphere can be reached from earth with the lowest cost in energy, and it is the natural and convenient spaceport location. In the next century LEO will contain a broad complex of assembly, research, repair, and production facilities. Their effective and cost-competitive use will require a class of routine workhorse transportation vehicles whose importance might be over-looked at a time when dramatic space exploration is occurring. Yet it is these vehicles, the Aeroassisted Space Transfer Vehicles (ASTV's) that will provide that solid transportation base on which a productive space industry will grow. The ASTV's will be assembled in orbit and will never return to earth's surface. They will be used to transfer people and material from high locations to LEO. They will reduce their high velocities in the outer reaches of the earth's atmosphere where aerodynamic drag will slow them to the appropriate speed for LEO. They will then maneuver out of the atmosphere and into a desired orbit. The present consensus is that this is the only cost-effective method of reducing the speed of such vehicles to the required level. The ASTV's will operate at very high altitudes where the atmosphere is exceptionally thin and the flight data need for their safe and efficient design are not adequately known. Much critical scientific research must be done to

build the technology base needed to make such a design. The research program discussed in this publication, the AFE, is specifically aimed at acquiring the knowledge for this technology base.
Author
Aeroassist; Aerospace Vehicles; Low Earth Orbits; Space Programs; Spacecraft Design; Aeromaneuvering; Interplanetary Transfer Orbits; Atmospheric Entry

19
SPACECRAFT INSTRUMENTATION

For related information see also 06 Aircraft Instrumentation and 35 Instrumentation and Photography.

19970026377 Office National d'Etudes et de Recherches Aerospatiales, Div. de Thermophysique, Paris, France
ABLATION AND TEMPERATURE SENSORS FOR FLIGHT MEASUREMENTS IN REENTRY BODY HEAT SHIELDS
Cassaing, J. J., Office National d'Etudes et de Recherches Aerospatiales, France; Balageas, D. L., Office National d'Etudes et de Recherches Aerospatiales, France; Decom, A. A., Office National d'Etudes et de Recherches Aerospatiales, France; Lestel, J. C., Office National d'Etudes et de Recherches Aerospatiales, France; May 1995; 6p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Since 1977, ONERA has ground and flight tested different techniques for heat-shield recession: acoustic and combined temperature/ablation optical measurements. This last technique uses a gage that views the radiation optically from a cavity embedded within the heat shield. Flight measurements, both of temperature and of passage of the ablation front, are compared with data generated by a predictive numerical code. The ablation and the heat diffusion into the instrumented ablator can be simulated numerically to evaluate accurately the errors due to the presence of the gage. The ablation measurement alone of the reentry body nose is made by an acoustic gage. The temperature measurement alone of the heat shield inner wall will be soon carried out by an optical sensor.
Author
Ablation; Reentry Vehicles; Ablative Materials; Reentry Shielding; Spacecraft Shielding; Thermal Protection; Temperature Sensors; Temperature Measurement; Heat Measurement

20
SPACECRAFT PROPULSION AND POWER

19960003905 Societe Europeenne de Propulsion, Moissy-Cramayel, France
TESTS OF ENGINES HAVE STATIONARY PLASMA IN SIMULATED SPACE ENVIRONMENT *ESSAIS DE PROPULSEURS A PLASMA STATIONAIRE EN AMBIANCE SPATIALE SIMULEE*
Valentian, Dominique, Societe Europeenne de Propulsion, France; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 11 p; In French; See also 19960003881; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The SEP (European Company of Propulsion) developed a testing facility making it possible to carry out the acceptance tests of engines SPT 100 and the tests of development of an engine of second generation SPT MK 2. This installation results from the modification of an existing vacuum chamber. It is fitted with a cryogenic pump of great capacity making it possible to pump Xenon effectively, of a balance of measurement of pushed and an automatic system of control of test. The results obtained are compared favorably with those recorded on bulkier installations with the USA and in Russia.
Author
Aerospace Environments; Automatic Control; Cryogenics; Plasma Propulsion; Pumps; Spacecraft Power Supplies; Test Facilities; Thrustors; Xenon

19960008952 Fraunhofer-Inst. fuer Chemische Technologie, Pfinztal, Germany
EMISSION SPECTROSCOPY AND PYROMETRY OF PROPELLANT FLAMES AND SOLID ROCKET EXHAUST PRODUCTS
Eisenreich, N., Fraunhofer-Inst. fuer Chemische Technologie, Germany; Liehmann, W., Fraunhofer-Inst. fuer Chemische Technologie, Germany; Weiser, V., Fraunhofer-Inst. fuer Chemische Technologie, Germany; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 9 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The development of solid propellants is a major topic at the institute. For the purpose of getting more insight into the combustion behaviour of solid propellants and the exhaust plume signatures of rocket motors some new spectroscopic and pyrometric devices were developed. In the UV-VIS-region an Optical Multichannel Analyzer (OMA) is used. For the detection of radiation in the IR -region three systems are available ranging from 1.2 to 14.5 micron with a wavelength resolution of about 1 percent and a scanning rate of 10 ms per spectrum. The time resolution of the two color pyrometer ranges from DC up to 50 kHz and detects fast particles with temperatures above 1000 K. In this paper these methods of investigation are described and illustrated in different applications.
Author
Combustion Products; Exhaust Emission; Exhaust Gases; Infrared Instruments; Optical Measuring Instruments; Particle Size Distribution; Pyrometers; Rocket Exhaust; Solid Propellant Combustion; Solid Propellants; Temperature Measurement

19960008965 British Aerospace Defence Ltd., Royal Ornance Div., Chorley, United Kingdom
DEMILITARIZATION OF LANCE ROCKET MOTORS
Sargent, Peter, British Aerospace Defence Ltd., UK; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 6 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

In 1992 Royal Ordnance was awarded contract by NAMSA for the demilitarization of NATO's European stock of Lance missile rocket motors. Lance is a liquid fueled surface to surface guided missile designed to give general battlefield support with either a nuclear or conventional capability at ranges of up to 130 km. The NAMSA contract required Royal Ordnance to undertake the following: (1) transportation of missiles from NATO depots in Europe to Royal Ordnance's factory at Bishopton in Scotland; (2) establishment of a dedicated demilitarization facility at Bishopton; and (3) demilitarization of live M5 and M6 training missiles by the end of 1994.
Author
Disposal; Lance Missile; Liquid Propellant Rocket Engines

19970034785 Phillips Lab., Edwards AFB, CA United States
STRUCTURAL/BALLISTIC INSTABILITY AGEOUT MECHANISM IN THE SPARROW MARK 52 SRM
Thrasher, D. I., Phillips Lab., USA; Empleo, P. R., Sparta, Inc., USA; May 1997; 8p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A three dimensional finite element analysis and a one dimensional incompressible flow model were used to investigate the interaction between the internal ballistics and the structural grain deformations for the Sparrow Mark 52 rocket motor. The results confirm earlier investigators' conclusions (based on two dimensional structural analysis) that a mechanism exists for pressure spiking driven by choking of the gas flow within the bore cavity due to grain structural deformations. Significant differences were found between the 2D and 3D results, however; the 3D analysis requires a higher propellant modulus to prevent choking under the same analysis conditions.
Derived from text
Ballistics; Stability; Structural Analysis; Rocket Engines; One Dimensional Flow; Incompressible Flow; Finite Element Method

19980018680 Phillips Lab., Edwards AFB, CA United States
ROCKET RAMJET BOOSTERS FOR SUSTAINED HIGH SPEED FLIGHT
DeGeorge, Drew, Phillips Lab., USA; Hewitt, Pat, Atlantic Research Corp., USA; Siebenhaar, Adam, GenCorp Aerojet, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 10p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Sustained high speed flight requires the highest levels of propulsive and aerodynamic performance. One of the highest performance classes of propulsion system envisioned is the air augmented rocket. The potential for significant Imp increases to be gained using an air augmented rocket (with either liquid, solid or hybrid propellant boost propulsion systems) has long been recognized. Using intake air as the primary oxidizer with rocket fuel significantly reduces on-board propellant mass, vehicle mass and volume for the same total impulse delivered compared to conventional chemical rockets. The list of technical challenges for viability and use include: (1) Booster configuration including integrated (boost propellant inside air-augmented combustion chamber, with or without a typical rocket nozzle), parallel or tandem boosters, and propellant combination drives booster complexity, need for ejecta, boost system ballistic requirements, air-augmented rocket performance and vehicle aerodynamics; (2) Complexity of starting flow through the inlets and initiating efficient air-augmented ignition; and (3) Aerodynamics involved in starting and unstarting inlets in supersonic flow while performing high angle of attack maneuvers can negatively impact missile performance.
Derived from text
Rocket Engines; Aerodynamic Characteristics; Booster Rocket Engines; Propulsion System Configurations; Propulsion System Performance; Hybrid Propellants; Propellant Combustion; Supersonic Flow; High Speed

19980019003 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
STRUCTURAL ASSESSMENT OF SOLID PROPELLANT GRAINS ***L'EVALUATION STRUCTURALE DES BLOCS DE POUDRE A PROPERGOL SOLIDE***
Dec. 1997; 208p; In English
Report No.(s): AGARD-AR-350; ISBN 92-836-1063-6; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

Solid propellant rocket motors and gas generators are used in military and civil devices. Missiles, boosters, space propulsion, pyrotechnic actuators are examples. The structural capability of the grain over time and under varying temperature, humidity, and mechanical loads, is of prime concern for the reliability, safety and service life of the device. From 1994 to 1996 an AGARD working group has collected, reviewed and evaluated the methods used for structural analysis of solid propellant grains within the NATO nations and has issued an advisory report consisting of 8 chapters: (1) Overview of Solid Propellant Rocket Motor Design; (2) Application of Structural Integrity Assessment; (3) Structural Analysis; (4) Material Characterization; (5) Failure Criteria; (6) Margin of Safety Determination; (7) Verification; and (8) Recommendations and Conclusions. Standardization and preferable approaches are recommended.
Author
Propellant Grains; Solid Propellants; Structural Analysis; Standardization

19980206029 Arnold Engineering Development Center, Arnold AFS, TN United States
APPLICATION OF LASER-INDUCED FLUORESCENCE (LIF) TO LIQUID-PROPELLANT ROCKET ENGINE TESTING
Brasier, C. W., Sverdrup Technology, Inc., USA; Drakes, J. A., Sverdrup Technology, Inc., USA; Simmons, M. A., Sverdrup Technology, Inc., USA; May 1998; 10p; In English; See also 19980206002; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Combustion exhausts present a challenging problem for researchers due to the extremely harsh environment, and nonintrusive diagnostics are often sought to provide flow property information. Laser-induced fluorescence (LIF) is one technique in which a chosen flow molecule or marker is probed to yield gross flow properties, such as static temperature and flow velocities. The work presented herein describes the application of LIF to the combustion exhausts of several full-scale liquid-propellant rocket engines spanning a wide range of operational parameters. The method is based upon the use of cw ring-dye lasers which scan in frequency over either the Na D1 or D2 line at 5896 and 5890 A. Na is used as a basis for this approach since it occurs as a trace element in both hydrogen and amine rocket fuels. The generic apparatus is described, including a discussion of the collection and interpretation of the LIF signal to yield radial and temporal profiles of radial flow velocity, static temperature, and fuel distribution. It was found that the LIF technique provides quality data in most cases. Certain stressing situations were also found in which data on the flow properties were not obtainable. Also, computational fluid dynamics (CFD) modeling of the plumes was used to provide baseline estimates of the exhaust flow properties. The model reasonably predicted the gross behavior of the flow as determined by the LIF technique, although some items of fine spatial structure were not reproduced very well.
Author
Laser Induced Fluorescence; Liquid Rocket Propellants; Test Stands; Flow Characteristics; Flow Velocity; Temperature Distribution; Plumes; Sodium

19990014374 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
PULSE DETONATION WAVE ENGINE
Edelman, Raymond, Advisory Group for Aerospace Research and Development, France; Henderson, Robert E., Editor, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 91-93; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Tactical missiles based on Pulse Detonation Wave Engines (PDEs) have the potential of increased range, enhanced survivability, lower cost, and reduced time of flight. The advantages derive from two overall features of the intermittent combustion device compared to competing steady flow engines. The first feature is the quasi-constant volume characteristic of the detonative combustion process with theoretical increases of the specific impulse and the thermodynamic cycle efficiency. The second feature is related to a simple design which combines compression, combustion, and thrust production in one component. The paper discusses various missile applications of the detonation based cycle, several design issues, and R&D needs which have to be resolved to take full advantage of the PDE.
Author
Detonation Waves; Missile Systems; Pulsejet Engines; Design Analysis

23
CHEMISTRY AND MATERIALS (GENERAL)

19970001697 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
SMART STRUCTURES AND MATERIALS: IMPLICATIONS FOR MILITARY AIRCRAFT OF NEW GENERATION ***STRUCTURES ET MATERIAUX INTELLIGENTS: LES RETOMBES POUR LES AERONEFS MILITAIRES DE LA NOUVELLE GENERATION***
Oct. 1996; 152p; In English, 30-31 Oct. 1996, Philadelphia, PA, Amsterdam, Paris, USA, Netherlands, France; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19970001698 through 19970001709
Report No.(s): AGARD-LS-205; ISBN 92-836-1042-3; Copyright Waived; Avail: CASI; A08, Hardcopy; A02, Microfiche

Smart materials and structures technology is the integration of sensing and actuation elements into a structure or even more ambitiously into a material, with sensor and actuator being linked by a controller. Materials actually favored for integration include optical fibers and piezoelectric materials with respect to sensors, piezoelectric and electrostrictive materials, shape memory alloys or electrorheological fluids with respect to actuators and microprocessors, neural networks, fuzzy logic and various types of signal processing with respect to control. The first part of the lecture series is mainly focussed on understanding the fundamentals of smart materials and structures technology and achieving the capability to judge the use of that technology with respect to individual applications. Presentations related to sensor and actuator materials, mechanics of smart structures, control and data processing, as well as structural integration of sensors, actuators, and generally electronics are therefore the focus of this part. In a second part, applications of smart structures technology are considered with respect to aircraft. Topics to be

covered include monitoring the health/damage of aircraft structures or components, conceptual design of an adaptive wing, and electromagnetic antennae and their structural integration.
Author
Smart Structures; Shape Memory Alloys; Rheology; Piezoelectricity

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COMPOSITE MATERIALS

19950017082 Virginia Univ., Center for Electrochemical Science and Engineering., Charlottesville, VA, United States
THE DETECTION AND ANALYSIS OF GALVANIC DAMAGE IN BMI/GRAPHITE FIBER COMPOSITES
Taylor, S. R., Virginia Univ., USA; Cahen, G. L., Jr., Virginia Univ., USA; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 12 p; In English; See also 19950017076; Sponsored by Virginia Center for Innovative Technology and Naval Air Warfare Center; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The use of graphite fiber polymer matrix composites (GFPMC) in multi-material assemblies which must maintain mechanical integrity in aqueous environments has focused attention on the galvanic degradation of these materials. of recent concern to the aerospace industry is the galvanic degradation of bismaleimide (BMI)-graphite fiber (GF) composites when galvanically coupled to an active metal (e.g. aluminum). A detailed understanding of the damage process, both in terms of mechanism and extent, has not been possible because of the lack of sensitive method to detect, quantify, and characterize damage in this material system. This study has used electro-chemical impedance spectroscopy (EIS) to monitor material interfacial changes in an 8-ply, 0 deg, unidirectional BMI-GF composite subjected to cathodic and anodic polarization in NaCl solutions, exposure to caustic solutions, and galvanic coupling to a series of metals (Al, Fe, Cu, Ti) in NaCl solutions. Cathodic polarization was found to produce porous electrode behavior which was attributed to breakdown of the fiber/matrix interface and subsequent moisture ingress. This is in contrast to caustic exposure which did not show a porous electrode response, presumably due to general BMI solvation. These electrochemical results in combination with mechanical shear tests performed in an array of chemical and electrochemical conditions indicate that long-lived reaction intermediates, e.g. peroxide and superoxide radicals, generated during the oxygen reduction reaction on graphite, not hydroxyl ions, are the key damaging species. This will have important implications to the development of more damage resistant polymer chemistries. The sensitivity of EIS has also indicated that couples to titanium, proposed to be a benign couple, caused changes in the impedance spectra similar to those for low cathodic overpotentials. The long term implications of these latter changes on composite durability are not known at this time, but warrant further evaluation.
Author
Bismaleimide; Damage; Degradation; Electrical Impedance; Electrochemistry; Exposure; Fiber Composites; Graphite; Polymer Matrix Composites; Spectral Methods

19960020341 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
ADVANCED POLYMERIC & METALLIC COMPOSITE MATERIALS FOR SPACE AND AEROSPACE VEHICLE STRUCTURES AND STRENGTH OPTIMIZATION OF COMPOSITE STRUCTURES AND THEIR CERTIFICATION *LES MATERIAUX COMPOSITES POLYMERIQUES ET METALLIQUES AVANCES POUR LES STRUCTURES DES VEHICULES SPATIAUX ET AEROSPATIAUX, ET LOPTIMISATION DE LA RESISTANCE DES STRUCTURES COMPOSITES ET LEUR HOMOLOGATION*
DEC. 1995; 152p; In English; The AGARD SMP Lecture Series, 11-12 Dec. 1995, Stuttgart, Germany, Chatillon, France, Ohio, USA, USA, USA, USA; See also 19960020342 through 19960020351
Report No.(s): AGARD-LS-204; ISBN 92-836-1027-X; Copyright Waived; Avail: CASI; A08, Hardcopy; A02, Microfiche

This lecture series presents and discusses the scientific problem of advanced polymer and metallic composite materials for aerospace structures, strength optimization of composite structures, and their certification. Some challenges of using composite structures, including airframe concept definition, are studied. Fiber orientation optimization principles for composite panels and shells are outlined. Procedures for certification of assemblies made out of composites are dealt with. Certification requirements, including requirements to estimate static and fatigue strengths, are formulated. Design conditions for composite structures are analyzed, including development.
Author (revised)
Composite Structures; Polymer Matrix Composites; Metal Matrix Composites; Fatigue Life; Aircraft Structures; Fiber Composites; Structural Design; Aircraft Construction Materials; Spacecraft Construction Materials

19960020342 Central Aerohydrodynamics Inst., Zhukovsky, Russia
INTRODUCTION AND OVERVIEW
Biryuk, V.I., Central Aerohydrodynamics Inst., Russia; Advanced Polymeric & Metallic Composite Materials for Space and Aerospace Vehicle Structures and Strength Optimization of Composite Structures and their Certification; DEC. 1995, 1-1 - 1-13; In English; See also 19960020341; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

A general discussion of the application of composite materials to airframes is presented. An overview of mechanical properties and the effect of layup is given. Factors that weaken the structure, including scatter in mechanical properties, the sensitivity of structural characteristics to environmental attack and length of service, and brittleness and the related sensitivity to stress concentration and impacts, are outlined. Polymer matrix composites are then compared to metal matrix composites. The paper concludes with a look at future generations of polymer matrix composites.
CASI
General Overviews; Metal Matrix Composites; Polymer Matrix Composites; Airframes; Mechanical Properties; Composite Structures

19960020343 Russian Inst. for Aviation Materials, Moscow, Russia
ADVANCED POLYMER COMPOSITES: APPLICATION FOR AVIATION AND AEROSPACE STRUCTURES
Sorina, T. G., Russian Inst. for Aviation Materials, Russia; Advanced Polymeric & Metallic Composite Materials for Space and Aerospace Vehicle Structures and Strength Optimization of Composite Structures and their Certification; DEC. 1995, 2-1 - 2-17; In English; See also 19960020341; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Considered are issues related to improvement of properties, fabrication and use of polymer matrix composites (PMCs) based on graphite, organic, and glass fibers for aerospace industries of Russia and other countries of the CIS. The best effect is shown to be attained when a partial involvement of these materials (for making certain structures) is transformed into 'global' design of large structures out of the PMCs.
Author
Aircraft Structures; Composite Structures; Polymer Matrix Composites; Fiber Composites; Mechanical Properties

19960020344 Russian Inst. for Aviation Materials, Moscow, Russia
ADVANCED METAL MATRIX COMPOSITES
Salibekov, S.E., Russian Inst. for Aviation Materials, Russia; Advanced Polymeric & Metallic Composite Materials for Space and Aerospace Vehicle Structures and Strength Optimization of Composite Structures and their Certification; DEC. 1995, 3-1 - 3-21; In English; See also 19960020341; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The paper is devoted to fabrication and industrial use of metal matrix composites (MMC), in particular, Al/B, Al/C, and Al/SiC. Properties of MMCs are considered in relation to microstructures and specific manufacturing procedures.
Author
Aluminum Alloys; Fabrication; Metal Matrix Composites; Fiber Composites; Mechanical Properties; Microstructure

19960020345 Russian Inst. for Aviation Materials, Moscow, Russia
FUTURE GENERATION MATERIALS
Sorina, T.G., Russian Inst. for Aviation Materials, Russia; Advanced Polymeric & Metallic Composite Materials for Space and Aerospace Vehicle Structures and Strength Optimization of Composite Structures and their Certification; DEC. 1995, 4-1 - 4-12; In English; See also

19960020341; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The paper considers issues for the near future in the development of polymer matrix composites, including (1) effective use of nanocomponents and nano-level manufacturing processes for upgrading the physical (and mechanical) characteristics of composites; and (2) methods of development of 'smart' materials on the basis of functional components. The preparation of advanced thermosetting plastics that can be utilized as ready materials and matrices is described. The paper discusses the ability to predict the strengths of composites with nano-level components in which the strength, volume fractions, and spatial arrangement turn out to be interrelated.
Author (revised)
Polymer Matrix Composites; Fiber Composites; Smart Structures; Particulate Reinforced Composites; Microstructure

19960020346 Central Aerohydrodynamics Inst., Zhukovsky, Russia
RELIABILITY, MAINTENANCE AND LIFE CYCLES OF COMPOSITE STRUCTURES
Ushakov, A., E., Central Aerohydrodynamics Inst., Russia; Advanced Polymeric & Metallic Composite Materials for Space and Aerospace Vehicle Structures and Strength Optimization of Composite Structures and their Certification; DEC. 1995, 5A-1 - 5A-6; In English; See also 19960020341; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The rate of polymer matrix composites (PMCs) replacing metals depends on development of PMCs with necessary characteristics, availability of manufacturing facilities and high-rate manufacturing processes, and effective methods and technologies for designing and testing the composite structures. In order to substantiate selection of reasonable methods for ensuring safety and reliability of composite airframes made out of PMCs, the paper addresses (1) the experience in fulfilling airframe service life requirements and (2) information on in-service damage of composite structures. Limitations on the use of PMCs in primary structures include brittle fracture, environmental attack, scatter of mechanical characteristics, and the influence on PMC efficiency of methods adopted for ensuring airframe safety. Aspects of damage to PMCs, in particular damage in production, in-service damage, and models and characteristics of brittle fracture resistance, are discussed.
CASI
Airframes; Composite Structures; Fatigue (Materials); Fracture Strength; Polymer Matrix Composites; Structural Reliability

19960020347 Central Aerohydrodynamics Inst., Zhukovsky, Russia
DESIGN OF DAMAGEABLE AIRCRAFT POLYMER COMPOSITE STRUCTURES WITH A HIGH STRENGTH AND ENHANCED SERVICE LIFE
Ushakov, A. E., Central Aerohydrodynamics Inst., Russia; Advanced Polymeric & Metallic Composite Materials for Space and Aerospace Vehicle Structures and Strength Optimization of Composite Structures and their Certification; DEC. 1995, 5B-1 - 5B-25; In English; See also 19960020341; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Increasing the safety and service reliability of engineering structures made out of polymer matrix composites (PMCs) is a very challenging technical and economical problem. The structural and technological measures of providing service life of PMC aircraft structures are realized and verified while providing and improving the survivability through the following: (1) definition of PMC aircraft structure damages during manufacturing and service, (2) analysis of general and local stress-strain state of regular and nonregular structural zones, (3) prediction of the damage size growth and residual strength of PMC aircraft structures using the data of the damages and stresses in elements and joints, (4) determination of survivability based on probabilistic methods of predicting the failure of damaged PMC aircraft structures, (5) testing of structural schemes during preliminary and detailed design, and (6) full-scale static and fatigue laboratory tests of damaged PMC aircraft structures. A probabilistic model of failure is presented that accounts for a combination of structural, technological, and service aspects; the stochastic nature of service loads and mechanical impacts; and the scatter of damage or defect sizes and failure resistance characteristics of polymer composites.
CASI
Aircraft Structures; Composite Structures; Structural Failure; Polymer Matrix Composites; Reliability Engineering; Service Life; Structural Reliability

19960020348 Central Aerohydrodynamics Inst., Zhukovsky, Russia
COMPOSITE MATERIALS IN AIRCRAFT STRUCTURES (DESIGN, OPTIMIZATION AND CERTIFICATION)
Biryuk, V. I., Central Aerohydrodynamics Inst., Russia; Advanced Polymeric & Metallic Composite Materials for Space and Aerospace Vehicle Structures and Strength Optimization of Composite Structures and their Certification; DEC. 1995, 6-1 - 6-26; In English; See also 19960020341; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This report presents the scientific problem of composite structure optimization and certification. The approach to optimization of a lifting surface (a wing and empennage) is studied. The use of arbitrary anisotropic models in the design process is shown. Some examples of designing composite structures are included. Certification problems are briefly considered including the design conditions and means of compliance.
Author
Certification; Composite Structures; Aircraft Design; Structural Design; Aircraft Structures

19960020349 Central Aerohydrodynamics Inst., Zhukovsky, Russia
CERTIFICATION OF PREFORMS AND STRUCTURE ELEMENTS OF COMPOSITE MATERIALS
Trunin, Yuri P., Central Aerohydrodynamics Inst., Russia; Advanced Polymeric & Metallic Composite Materials for Space and Aerospace Vehicle Structures and Strength Optimization of Composite Structures and their Certification; DEC. 1995, 7-1 - 7-13; In English; See also 19960020341; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The cost-efficient approach for certification of preforms and elements of composite materials is presented. The criterion of certification is the requirements that A- or B-values of a characteristic concerned are not less than the design values for a typical zone considered. The most critical typical zones are the ones with manufacturing defects, in-service impact damages, and structural stress risers. Unlike the usual guidelines our method does not require testing specimens from all of the general population. The approach relies on static and fatigue tests of specimens from one material batch which has the worst average properties. As the worst material batch it is suggested to consider that which will be produced with critical per ply thickness from the allowable range of per ply thickness alteration. The A- or B-values may be determined on the basis of experiment and/or analysis in consideration of environmental effect. The experimental and analysis substantiations of the suggested approach are presented.
Author
Certification; Fatigue Tests; Preforms; Static Tests; Laminates; Fracture Strength; Fatigue Life; Polymer Matrix Composites

19960020350 Central Aerohydrodynamics Inst., Zhukovsky, Russia
DETERMINATION OF A- AND B-VALUES OF STRENGTH AND FATIGUE RESISTANCE FOR PREFORMS AND ELEMENTS OF COMPOSITES STRUCTURAL MATERIALS
Senik, V. Y., Central Aerohydrodynamics Inst., Russia; Advanced Polymeric & Metallic Composite Materials for Space and Aerospace Vehicle Structures and Strength Optimization of Composite Structures and their Certification; DEC. 1995, 8-1 - 8-6; In English; See also 19960020341; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

An efficient procedure for certification of composite structures is developed in accordance with which for calculating basic values of mechanical and fatigue properties it is enough to obtain test results for the objects certified in one batch only. The procedure is based on the probabilistic model, formed as summary of extensive experimental investigations of strength and fatigue properties for composite materials, preforms, and elements made of them. Estimation error for basic

values according to the proposed procedure does not exceed 5% when scatter values of strength and fatigue properties are typical for composite materials.
Derived from text
Fatigue Life; Fracture Strength; Preforms; Composite Materials; Static Tests; Fatigue Tests

19960020351 Central Aerohydrodynamics Inst., Zhukovsky, Russia
ENSURING COMPOSITE STRUCTURE STRENGTH
Biryuk, V. I., Central Aerohydrodynamics Inst., Russia; DEC. 1995, 6 p; In English; See also 19960020341; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The variation of properties of composite materials subjected to environmental attack and a method to evaluate these environmental effects are considered. Airframes, while in long-term service and/or storage, experience adverse temperature/humidity combinations which usually change the mechanical properties governing the material limits. The moisture absorbed decreases strengths and stiffnesses, thus increasing in-service deformation. Elevated temperatures intensify moisture absorption. Fibers are less sensitive to moisture than polymer matrices; therefore the moisture content may severly influence properties defined by the matrix strength, i.e., the compressive and shear stress limits. The impact of the in-service environment on the static, fatigue, and residual strengths (and stiffnesses) of full-size structural elements can be tested by a program which incorporates the maximum temperature likely to occur in service, the minimum temperature defined by the basic conditions and/or long flights at high altitudes, extreme accumulation of moisture, and dwelling of the structure in severe environment during the service life.
Derived from text
Airframes; Composite Materials; Fracture Strength; Moisture; Polymer Matrix Composites; Fatigue Tests; Thermal Cycling Tests; Environmental Tests

19960021135 NYMA, Inc., Cleveland, OH United States
A SUMMARY OF DAMAGE MECHANISMS AND MECHANICAL PROPERTY DEGRADATION IN TITANIUM MATRIX COMPOSITES SUBJECTED TO TMF LOADINGS
Castelli, Michael G., NYMA, Inc., USA; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 12p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

An overview of thermomechanical fatigue (TMF) deformation, damage progression, and life is presented for multiple laminates of continuous SiC fiber reinforced titanium matrix composites (TMC's). Fundamental behaviors resulting from in-phase (IP) and out-of-phase (OP) TMF loadings are addressed with particular emphasis on the micromechanical damage mechanisms leading to macroscopic failure. This is accomplished through detailed microstructural examinations using both fractography and metallography. Further, macroscopic measures of damage progression based on mechanical property degradation are examined through data collected using an advanced TMF test technique which allows explicit measurements of the macroscopic (1) isothermal static moduli and (2) coefficient of thermal expansion (CTE) as functions of the TMF cycles. Zero-tension TMF life results indicate analogous trends for both (0) and (0/90) TMC laminates. High stress IP TMF and mid to low stress OP TMF loadings are life-limiting in comparison to maximum temperature isothermal conditions. Dominant damage mechanisms changed with cycle type. Damage resulting from IP TMF conditions produces measurable decreases in static moduli but only minimal changes in CTE occur. Microstructural damage is dominated by extensive (0) fiber cracking with sparse matrix damage and no surface initiated cracking. Under OP TMF conditions, notable static moduli and CTE degradations are experienced. Here, conditions promote environment enhanced surface initiated cracking. The (0/90) TMC also exhibits matrix cracking initiated at debonded (90) fiber/matrix interfaces. Both laminates show little to no (0) fiber cracking. Zero-tension TMF of a (90) TMC reveals significant changes in both the static moduli and CTE under IP and OP conditions. Mechanical property degradation patterns are very similar to those exhibited under isothermal loadings. Further, damage mechanisms promoted by isothermal, IP TMF and OP TMF loadings are essentially identical, consisting of debonding at the fiber/matrix interface followed by matrix cracking which initiates at the debond and propagates transverse to the applied load.
Author
Metal Matrix Composites; Titanium; Damage Assessment; Thermodynamic Properties; Thermal Fatigue; Fiber Composites; Thermal Stresses; Laminates; Crack Propagation

19960021136 Naval Air Warfare Center, Aircraft Div., Patuxent River, MD United States
TMF RESPONSE OF TI-48AL-2V ALLOY AND ITS COMPOSITE
Lee, E. U., Naval Air Warfare Center, USA; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 14p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The fatigue behavior of a Ti-48Al-2V alloy and its composite, reinforced with particulate TiB2, was investigated under in-phase thermal-mechanical cycling and isothermal cycling. In the thermal-mechanical fatigue (TMF) tests, the temperature was cycled between a minimum temperature T(sub min), 100 C, and a maximum temperature T(sub max) ranging from 750 C to 1400 C; the cyclic stress ranges were 2.8 - 28 MPa and 4.2 -42 MPa. Employing the identical cyclic stress ranges, isothermal fatigue (IF) tests were conducted at a T(sub max). The lower the T(sub max) and the smaller the stress range, the longer was the TMF and IF lives for the Ti-48Al-2V alloy and its composite. IF inflicted damage earlier than TMF in the Ti-48Al-2V alloy, whereas their damaging effects were similar in the composite. Both materials had similar TMF resistance, but the composite showed greater IF resistance than Ti-48Al-2V alloy. The TMF mechanism is nucleation and growth of voids in interlamellar plate, twin and grain boundaries, their linkage, intergranular separation, and disintegration of lamellar structure.
Author
Damage Assessment; Thermal Fatigue; Titanium Alloys; Aluminum Alloys; Thermal Stresses; Thermal Cycling Tests; Fatigue Tests; Thermodynamic Properties

19970001698 Daimler-Benz Aerospace A.G., Military Aircraft, Munich, Germany
GENERAL INTRODUCTION
Boller, Christian, Daimler-Benz Aerospace A.G., Germany; Oct. 1996; 8p; In English; See also 19970001697; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Development in disciplines such as sensing technology, computation, control, micromechanics, materials including processing and many others has made significant progress during the past decades. This progress has been mainly possible through an in-depth analysis of the different aspects in these disciplines. to consequently take more advantage of this progress a synergy between these different disciplines has to be established, resulting in what has been termed to be smart materials and structures. Smart (alternatively active, adaptive, multifunctional or intelligent) materials and structures is - briefly explained - the integration of sensing and actuation elements into a structure or even more ambitiously into a material, with sensor and actuator being linked by a controller. Materials actually favored for integration include optical fibers and piezoelectric materials with respect to sensors, piezoelectric/electrostrictive materials, shape memory alloys and electro-rheological fluids with respect to actuators and microprocessors, neural networks, fuzzy logic and various types of signal processing with respect to control. Since performance of military aircraft and spacecraft has progressed in a sequence of steps in the past, smart materials and structures technology can thus be considered to be a next step in enhancement.
Author
Smart Structures; Shape Memory Alloys; Rheology; Piezoelectricity; Electrostriction; Military Spacecraft

19970001699 Virginia Univ., Intelligent Processing of Materials Lab., Charlottesville, VA United States
CHARACTERISTICS AND PROCESSING OF SMART MATERIALS
Wadley, Haydn N. G., Virginia Univ., USA; Smart Structures and Materials: Implications for Military Aircraft of New Generation; Oct. 1996; 18p; In English; See also 19970001697; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Smart materials are revolutionary new engineering materials/ intelligent structures that sense and respond to their environment.

Emerging concepts for mission adaptable wings, helicopter blades and the active suppression of submarine noise are reviewed and used to identify the important basic elements of these intelligent structures. The fundamental principles of the main sensing approaches (based on piezoelectric, fiber optic, luminescent and other phenomena) are described together with the physical principles underlying approaches to actuation (piezoelectric/ electrostrictive materials, magnetostriction, shape memory alloys and electrorheological fluids). The best methods for design and processing of affordable smart materials are only beginning to be addressed by researchers; concurrent engineering and intelligent processing of materials concepts will be essential to transition smart materials from the laboratory into applications.
Author
Shape Memory Alloys; Smart Structures; Piezoelectricity; Electrorheological Fluids

19970019653 Hughes Technical Center, Atlantic City International Airport, NJ United States
BOLTED JOINTS IN COMPOSITE STRUCTURES: AN OVERVIEW
Oplinger, D. W., Hughes Technical Center, USA; AGARD Conference Proceeding: Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 12p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Investigations of bolted joints from the introduction of advanced composites in the mid-to-late 1960's to the present are reviewed. Numerous efforts aimed at applying two dimensional elastic stress analysis in conjunction with appropriate testing have been conducted. Modelling of the pinplate contact problem by a radial displacement condition rather than a radial pressure distribution is physically more realistic and has been done in a number of efforts, starting with that of Oplinger and Gandhi in the early 1970's. However in the case of the problem of bearing-bypass stress interaction which is in principle controlled by the radial displacement description of the contact problem, a number of efforts have provided useful results, especially in conjunction with adjustments based on test data by superposition of the half-cosine radial pressure distribution for pure bolt bearing load and the open-hole plate solution for bypass load. Approaches to predicting failure using results of 2-D elasticity analysis are discussed. In addition, recent effort addressing bearing failure on the basis of the three dimensional stress state is considered. Currently, the details of the three-dimensional contact problem associated with bending deflections of the fastener as well as the interaction of the fastener head with the surfaces of the joint plate elements are seen to need additional study.
Author
Bolted Joints; Composite Structures; Composite Materials; Elastic Properties; Stress Analysis; Bolts

19970019654 National Research Council of Canada, Institute for Aerospace Research, Ottawa, Ontario Canada
BOLTED JOINT TECHNOLOGY IN COMPOSITE STRUCTURES: ANALYTICAL TOOLS DEVELOPMENT
Poon, C., National Research Council of Canada, Canada; Xiong, Y., National Research Council of Canada, Canada; Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 12p; In English; See also 19970019652
Contract(s)/Grant(s): DNDFE-220794NRC08; NCR Proj. 3G3; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Graphite fiber reinforced polymeric composites have been used extensively in the primary and secondary structures of modern military and civilian aircraft. In these structures, bolted joints are important considerations in structural design and repair. Reviews of the literature indicated that most of the current design methods were developed for single fastener Joints and, in general, design optimization, three dimensional effects and fatigue behaviour required further research and development. This paper reviews the results of the bolted joint technology development project sponsored by the Institute for Aerospace Research and the Canadian Department of National Defence. The project includes the development of computer-aided design tools for optimizing the design of multi-fastener composite joints and for predicting the fatigue behavior of pin/bolt loaded composite laminates. Current focus and future direction of the development of analytical tools for repair of composite structures and other applications are presented.
Author
Bolted Joints; Composite Structures; Fiber Composites; Fasteners; Graphite; Laminates; Bolts

19970019655 Wright Lab., WL/FIBAD, Wright-Patterson AFB, OH United States
A REVIEW OF COMPOSITE JOINT ANALYSIS PROGRAMS
Venkayya, V. B., Wright Lab., USA; Tischler, V. A., Wright Lab., USA; AGARD Conference Proceeding: Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 20p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Several joint analysis programs funded by U.S. government agencies during the 1970s, 1980s and 1990s were reviewed. The review covered bolted, bonded, bolted-bonded and repair programs. In a few cases the results obtained from these programs are compared. A number of related references were cited for the purpose of obtaining additional details.
Author
Bolted Joints; Bolts; Laminates; Composite Materials

19970019664 Defence Research Agency, Structural Materials Center, Farnborough, United Kingdom
SURFACE TREATMENT AND BONDING OF THERMOPLASTIC COMPOSITES
Shaw, S. J., Defence Research Agency, UK; Comyn, J., Defence Research Agency, UK; Mascia, L., Loughborough Univ. of Technology, UK; Jan. 1997; 12p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The use of structural adhesives in engineering applications can offer substantial benefits in comparison to more traditional joining techniques such as mechanical fastening and welding. These include: Improved fatigue performance; ability to join dissimilar materials; ability to join thin gauge materials and honeycomb constructions; and simpler and cheaper component construction. Operational benefits which can result from the significant use of bonding include improved equipment performance, resulting largely from the significant weight reductions which adhesive bonding can provide, together with substantial reductions in both procurement and life-cycle maintenance costs. In particular, the use of adhesive bonding in the construction of advanced lightweight composite structures will be of major importance since mechanical fastening would impose penalties in terms of mechanical integrity and weight.
Derived from text
Adhesive Bonding; Thermoplasticity; Honeycomb Structures

19970019665 Politecnico di Milano, Dept. di Ingegneria Aerospaziale, Milan, Italy
HYGROTHERMAL FATIGUE OF COMPOSITE BONDED JOINTS
Giavotto, V., Politecnico di Milano, Italy; Caprile, C., Politecnico di Milano, Italy; Sala, G., Politecnico di Milano, Italy; Jan. 1997; 10p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Adhesive bonding is the optimal technique to join composite laminates, because it does not induce stress concentrations, fibres cutting, resin delaminations and problems due to electrochemical non-compatibility. Notwithstanding, in many cases bolted and riveted joints have to be used, mainly in hot-wet environmental conditions. as well as when composites have to face chemically aggressive fluids, as hydraulic and de-icing fluids, oils and fuels. Moreover, the influence exerted on bonded joints by technological defects (voids, inclusions) and barely visible damages (due to low-energy impacts) should be addressed. The results of a research on the fatigue behaviour of wet-conditioned, impacted and defective composite bonded joints are reported. Single and double lap geometry carbon fabric/epoxy joints are considered. bonded with high-toughness adhesive. The specimens were wet-conditioned in hot water (70 C) up to saturation. Barely visible damages were produced in the bonded region (influencing both the composite adherents and the adhesive layer) by means of low-energy impacts (0.5 J per mm laminate thickness) imparted by a spring-propelled horizontal apparatus with 20 mm hemispherical steel impactor). Defective bondings were simulated by including copper inserts, located in different positions. Defective, impacted and wet conditioned specimens were subjected to static and constant ampli-

tude fatigue testing (tension-compression, R=I, 6Hz frequency); their performances were compared to the behaviour of plain specimens. The stiffness decrease and the damage growth were continuously monitored during the testing by means of extensometers and NDI techniques (ultrasonic scanning and dye penetrant radiography). The results consist in the comparison of the static stress-strain curves relevant to plain, defective, impacted and wet-conditioned specimens, the curves of stiffness decrease vs. number of cycles and the Woehler curves. Finally, the static characteristics and the fatigue performances are correlated with the damage growth and the adhesive progressive degeneration by analysing the radiographs and the SEM micrographs of the failed bonded region, in order to propose an interpretative model.
Author
Bonded Joints; Bolted Joints; Adhesive Bonding; Adhesives; Laminates; Stress-Strain Relationships; Riveted Joints; Resins; Hygral Properties

19970019667 Northrop Grumman Corp., Military Aircraft Systms Div., Pico Rivera, CA United States
ATTACHMENT OF CERAMIC MATRIX COMPOSITES OF AFR700B COMPOSITES FOR EXHAUST WASHED AIRFRAME STRUCTURES
Atmur, Steven, Northrop Grumman Corp., USA; Colby, Mary, Northrop Grumman Corp., USA; Tomasek, Mary, Northrop Grumman Corp., USA; Hagen, Michael, Northrop Grumman Corp., USA; Sherrill, David, Northrop Grumman Corp., USA; Foreman, Charles, Northrop Grumman Corp., USA; Dolvin, Douglas, Wright Lab., USA; Jan. 1997; 10p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Current industry practice separates the design of an air vehicle's propulsion system from the design of its airframe. This practice causes many problems and inefficiencies particularly for advanced exhaust nozzle designs. It results in redundant aircraft structure to be insulated and shielded from the engine thermal and acoustic emanations. Perhaps, most importantly, it causes buckling and cracking at the joint interfaces where the thermally induced stresses are reacted. The critical joint interfaces are the co-cured/bonded joints between layers of dissimilar materials and the mechanical joints between structural components. Northrop Grumman's concept is to modernize the design, analysis, and construction of future high performance aircraft by integrating the exhaust nozzle/ exhaust washed structural components into the primary airframe structure through a combination of organic and ceramic matrix composite materials. Designing bolted and bonded joints to carry induced loads efficiently, then, is critical to an integrated structural approach. Northrop Grumman has evolved a variety of approaches to transfer loads, including co-bonding of dissimilar materials and unique joint designs. Ceramic matrix composite/ AFR700B bolted and bonded joints have been identified as a critical need, and under Air Force-contracted research, joints have been designed and analyzed and will be fabricated. Sub-element testing, including static and fatigue, will validate the design and analytical methodologies. Durability and maintainability will be validated through testing and nondestructive evaluation. Trade-off analysis performed on the bolted and bonded joints will address structural efficiency, reliability, supportability, and battle damage tolerance.
Author
Ceramic Matrix Composites; Bolted Joints; Bonded Joints; Insulation; Laminates; Structural Design; Systems Engineering; Temperature Effects

19970019668 Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX United States
3-D COMPOSITES IN PRIMARY AIRCRAFT STRUCTURE JOINTS
Bersuch, Larry, Lockheed Martin Tactical Aircraft Systems, USA; Hunten, Keith, Lockheed Martin Tactical Aircraft Systems, USA; Baron, Bill, Wright Lab., USA; Tuss, James, Wright Lab., USA; Jan. 1997; 10p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Three-dimensional woven and braided inserts and preforms, when cocured into primary wing and fuselage laminate structure, offer reduced weight, increased performance, lower costs, and improved damage tolerance and ballistic survivability for future aircraft. to achieve these benefits, three-dimensional (3-D) weaving and braiding technologies must be characterized through the development of design criteria, design methods, structural concepts, and manufacturing processes. In addition to 3-D weaving and braiding, z-direction reinforcement can be achieved through in-process fiber insertion with processes such as z-spiking, stitching, and short fiber additions to adhesives. Innovative applications of these technologies, combined with net shape curing processes such as resin transfer molding (RTM), electron beam cure, diaphragm forming, fiber placement, and cocuring, will result in the elimination of machined metal load fittings, fasteners, and reduction in weight at composite joints on future aircraft. Wing applications for 3-D composites would be at the intersection of spars and ribs and in the radius area between spars/ribs and the lower skin of a cocured wing assembly. In fuselage structure, 3-D composites eliminate the need for machined fittings and fasteners at concentrated load joints such as those at inlet duct, weapons bay, gun-trough, and fuel floor intersections with bulkheads/frames. This paper is directed at design for manufacturing of 3-D composite structures to best exploit the structural properties that they exhibit.
Author
Aircraft Structures; Composite Materials; Composite Structures; Curing; Fuselages; Laminates; Resin Transfer Molding; Wings; Three Dimensional Composites; Structural Design

19970019669 Aztex, Inc., Waltham, MA United States
Z-FIBER TECHNOLOGY AND PRODUCTS FOR ENHANCING COMPOSITE DESIGN
Freitas, G., Aztex, Inc., USA; Fusco, T., Aztex, Inc., USA; Campbell, T., Foster-Miller Associates, Inc., USA; Harris, J., Foster-Miller Associates, Inc., USA; Rosenberg, S., Foster-Miller Associates, Inc., USA; Jan. 1997; 8p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Z-Fiber(TM) technology uses small, solid, cylindrical pins to greatly enhance the performance of composite structures. These pins, typically 0.25 to 0.50 mm in diameter, can be used for many structural applications. Z-Fibers, either composite or metal, are inserted through the thickness of a composite laminate to increase out-of-plane strength, damage resistance, and through thickness thermal conductivity. Z-Fiber is also used for structural joints and can be designed to be the structural network of the core material in an extremely weight and cost efficient sandwich structure. Z-Fiber technology has been under development for over ten years. The growth of this technology, originally developed by Foster-Miller Inc., has begun to move at a very accelerated rate under Aztex Inc. during the past two years. Despite this extended development period, the revolutionary advances in the performance of composite structures made possible by this technology are only now becoming fully apparent. When used at the conceptual stage of aircraft design, when the overall structural arrangement is being formulated, Z-Fiber technology can completely change the current design approaches. This paper presents a general overview of Z-Fiber technology and products and focuses on the work to date to form structural joints. The paper demonstrates, even at this early stage of development, Z-Fiber's capability to outperform fasteners and significantly increase the static survivability of composites.
Author
Composite Structures; Aircraft Design; Thermal Conductivity; Structural Design; Sandwich Structures; Laminates

19980018703 Aerospatiale, Espace et Defense Branch, Cannes, France
LIGHTWEIGHT MATERIALS FOR ENGINES AND STRUCTURES
Capdepuy, B., Aerospatiale, France; Peres, P., Aerospatiale, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 6p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Hypersonic flight constitutes for materials developers a big challenge considering the requirements they have to be compliant with. The mastering of this key technology is necessary to design hypersonic vehicle as they are needed to realize the thermal protection system as well as some parts of engines. The requirements can be identified ranking in three categories which are technical, industrial feasibility and producing costs. These three topics will be discussed in this paper. For the thermal protection system of reentry vehicles, carbon/carbon composites protected against oxidation as well as carbon/silicon carbide composites have already demonstrate they are good candidates to sustain high thermomechanical loads. But in order to be compliant with development costs of future system an effort has to be performed in simplified designs. For future engines as scramjet requirements are much more severe but a first demonstration of appli-

cability of such materials has been performed on an injection strut. Nevertheless the demonstration of behaviour of the coatings to combustion ambiances has yet to be demonstrated for long term and reusable applications.
Author
Hypersonic Flight; Carbon-Carbon Composites; Thermal Protection; Costs; Elastic Properties; Reentry Vehicles; Silicon Carbides; Hypersonic Vehicles

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INORGANIC AND PHYSICAL CHEMISTRY

19950017084 Defence Research Establishment Pacific, Victoria British Columbia, Canada
THE USE OF ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY TO PREDICT THE CORROSION OF ALUMINUM-LITHIUM ALLOYS IN MARINE ENVIRONMENTS
Lenard, D. R., Defence Research Establishment Pacific, Canada; Moores, J. G., Defence Research Establishment Pacific, Canada; Roberge, P. R., Royal Military Coll. of Canada, Canada; Halliop, E., Royal Military Coll. of Canada, Canada; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 12 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

In order to acquire some experience with the behavior of aluminum-lithium alloys in the marine environment, the Defense Research Establishment Pacific compared panels made from Aluminum Alloy (AA) 2090 and 8090 sheet with the conventional alloys AA 7075 and 2024, respectively, in several tests involving long term exposure to sea water fog and full or partial immersion in sea water. The results of these were then compared with the results of a new technique, developed by the Royal Military College of Canada for the analysis of electrochemical impedance measurements, that was performed on these alloys in simulated sea water. The long term exposure tests indicated that corrosion problems could occur with aluminum-lithium alloys in the marine environment. The 8090 alloy was found to suffer from severe localized attack, including intergranular cracking, along edges that were immersed in sea water. The 2090 alloy, however, appeared to offer some advantages over its 7075-T6 counterpart, as it was more resistant to corrosion at its edges, even though it suffered as much or more corrosion on the rolled surfaces. On some 2090 panels, the corrosion resistance of the edges was found to be enhanced by cold work associated with shearing. Polarization resistance measurements were generally consistent with the results of the long term exposure tests, although they predicted corrosion rates for the rolled surfaces of the 8090 and 7075 alloys that were apparently too high. The angle of depression of the Nyquist plots appeared to correlate with the number of corrosion sites within a given area and was in good agreement with visual observations of the long term exposure panels.
Author
Aluminum-Lithium Alloys; Corrosion; Corrosion Tests; Electrical Impedance; Impedance Measurement; Inspection; Marine Environments; Metal-Water Reactions; Spectral Methods; Spectroscopy

19960008957 Delegation Generale de l'Armement, Bourges, France
CHARACTERIZATION OF THE HEAT FLUX AND ESTIMATE OF THE RISKS OF BURNS AROUND THE ENGINES AT VERY SHORT TIME OF COMBUSTION *CARACTERISATION DU FLUX THERMIQUE ET ESTIMATION DES RISQUES DE BRULURES AUTOUR DES MOTEURS A TRES COURT TEMPS DE COMBUSTION*
Franco, P., Delegation Generale de l'Armement, France; Balageas, D., Delegation Generale de l'Armement, France; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 8 p; In French; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The heat flux around the engines of missiles or rockets is related to the ejection of a large quantity of hot gases during the shooting and can constitute an important harmful effect. In addition to the risks of ignition of the immediate environment (vegetation), these effects can involve risks of burns. In order to better take into account these effects, a study was undertaken in order to develop estimated tool risks of burns during a very short operating time of combustion. Thus, a methodology of characterization of the heat flux in the jet of the engines was studied. It was elaborate in order to take account of following specificities: very short response times due to the speed of the phenomena; mechanical resistance to projections of unburnt residues in the jet; representativeness of the heat fluxes in the skin; and distinction between flows - convective and radiative. In complement, a thermal model of the skin was studied. It is based on the model of skin of Stolwijk and Hardy and allows the calculation of the profile of temperature in the various layers of the skin: subcutaneous skin and fabrics. A law of destruction of the cells according to the temperature was derived from work of Henriques and Stoll and was adapted. This tool allows the forecast of the risks of burns around the engines; it can be used, in particular, to delimit the areas at the risks for the shootings in free field or closed space.
Author
Biological Effects; Burns (Injuries); Heat Flux; Heat of Combustion; High Temperature Gases; Physiological Responses; Rocket Engines; Skin (Anatomy)

19970021644 Cambridge Univ., Engineering Dept., Cambridge, United Kingdom
TURBULENT COMBUSTION
Bray, Ken, Cambridge Univ., UK; Turbulence in Compressible Flows; Jun. 1997, 3.1-3.74; In English; See also 19970021641; Copyright Waived; Avail: CASI; A04, Hardcopy; A03, Microfiche

This review is concerned with turbulent combustion in high speed flows. Its aim is to assess the current state of knowledge incorporated in theoretical models and, as with most turbulent flows, these models necessarily involve averaging. Because high speed turbulent combustion involves additional phenomena which are not well understood, we begin by considering combustion at low Mach numbers where a substantial body of theory exists. Our purpose is to identify the key role played by the low Mach number assumption and hence to define the particular challenge posed by high Mach number reactive flows. Experiments concerning high speed turbulent combustion in jet flames, high speed turbulent deflagration and transition to detonation are reviewed. Finally, problems involved in modeling and prediction of high speed turbulent combustion are identified and discussed. It is concluded that convincing theoretical models are currently not available.
Author
Turbulent Combustion; Turbulent Flow; Hypersonic Flight; Turbulence Models; Jet Flow; Turbulence Effects; Fuel Combustion; Combustion Chemistry

19970034934 Institute of Aviation Medicine, Forensic Medicine and Medical Investigation of Aircraft Accidents, Fuerstenfeldbruck, Germany
ON THE COMPOSITION OF COMBUSTION GASES OCCURRING AFTER FLIGHT ACCIDENTS AND INCIDENTS AND THEIR ANALYTICAL PROOF OF EXISTENCE
Krause, Harald A. O., Institute of Aviation Medicine, Germany; Sep. 1997; 8p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In the course of flight accidents and incidents, diverse fires are frequently occurring. As a result, there are mostly gaseous or highly volatile combustion and pyrolysis products are arising which depend on the fire conditions (ventilation, temperature, etc.), the POL (petrol - which is jet fuel, aviation gas, oil, lubricant) in use and the plastic and compound material used in the manufacture of modern aircraft with their characteristic compositions. The exact knowledge of such products and their toxicological qualities is of major importance as well as their definite proof of existence when, according to forensic standards, such occurrences are investigated for possible impairment of human health as a result of flight incidents. The present study provides an overall view of gaseous or highly volatile products possibly resulting from post-crash and in-flight aircraft fires, together with the first results

from a new, high-resolution analytical system for definite substance identification which were obtained at the German Air Force Institute of Aviation Medicine.
Author
Combustion Products; Gas Composition; Aircraft Accidents; Aircraft Safety; Fires; Toxicity; Aerospace Medicine

19970037359 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
ACTIVE COMBUSTION CONTROL FOR PROPULSION SYSTEMS ***LE CONTROLE ACTIF DE LA COMBUSTION POUR LES SYSTEMES DE PROPULSION***
Schadow, K., Naval Air Warfare Center, USA; Yang, V., Pennsylvania State Univ., USA; Culick, F., California Inst. of Tech., USA; Rosfjord, T., United Technologies Corp., USA; Sturgess, G., Innovative Scientific Solutions, Inc., USA; Zinn, B., Georgia Inst. of Tech., USA; Sep. 1997; 52p; In English; In French; Propulsion and Energetics Panel, 6-9 May 1996, Athens, Greece
Report No.(s): AGARD-R-820; ISBN 92-836-1060-1; Copyright Waived; Avail: CASI; A04, Hardcopy; A01, Microfiche

Active combustion control is one of the most promising approaches to further optimize the size/weight/power relationship in rockets, ramjets, afterburners, aero-engines, and marine propulsion. A workshop was organized in Athens in spring 1996 under the sponsorship of the AGARD Propulsion and Energetics Panel. It covered the existing knowledge, and further possible strategies for military equipment were discussed within the NATO nations. Further activities are planned.
AIAA
Combustion Control; Active Control; Propulsion System Performance; Propulsion System Configurations; Afterburning; Aircraft Engines; Marine Propulsion; Ramjet Engines

19980204000 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne, Germany
ROTATIONAL AND VIBRATIONAL TEMPERATURE AND DENSITY MEASUREMENTS BY PLANAR LASER INDUCED NO-FLUORESCENCE SPECTROSCOPY IN A NONEQUILIBRIUM HIGH ENTHALPY FLOW
Koch, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Guelhan, A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Esser, B., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Grisch, F., Office National d'Etudes et de Recherches Aerospatiales, France; Bouchardy, P., Office National d'Etudes et de Recherches Aerospatiales, France; May 1998; 10p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

LIF experiments were performed in the flow field of the high enthalpy facility L2K. This arc heated facility, which is mainly used for testing thermal protection materials, offers a wide choice of flow conditions to simulate the stagnation conditions during shuttle re-entry. The flow conditions are dominated by non equilibrium effects. For the operation conditions of L2K, translational and rotational temperature are assumed to be in equilibrium, but large differences between rotational, vibrational, and electronic temperature occur. Laser induced fluorescence is used to determine rotational and vibrational temperature and the density of NO in the free stream and behind a bow shock upstream of a blunt body. The flow is modelled numerically using a quasi 1D-code. Good agreement is achieved between the experimental and numerical data in the free stream. The data are also compared with the CARS measurements performed at the same flow conditions in the same facility. Differences in the free stream vibrational temperature of N2 and NO are due to the faster vibrational relaxation of NO-molecules.
Author
Reentry Shielding; Thermal Protection; Density Measurement; Reentry Vehicles; Vibration

19980206003 Instituto Superior Tecnico, Dept. of Mechanical Engineering, Lisbon, Portugal
ON THE AEROTHERMOCHEMISTRY OF RECIRCULATING PREMIXED FLAMES WITH AND WITHOUT SWIRL
Duarte, D., Instituto Superior Tecnico, Portugal; Ferrao, P., Instituto Superior Tecnico, Portugal; Heitor, M. V., Instituto Superior Tecnico, Portugal; Advanced Non-Intrusive Instrumentation for Propulsion Engines; May 1998; 12p; In English; See also 19980206002
Contract(s)/Grant(s): CEC-CT-95-0106; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes recent progress in the analysis of the nature of turbulent premixed flames stabilised behind an axisymmetric baffle, which are of fundamental interest in the development of new and cleaner propulsion combustion systems. The work includes the use of laser-based diagnostics for velocity and temperature measurements, which are extended to the analysis of turbulence statistics, including the energy spectrum and typical length scales in a reacting shear layer. The results provided experimental evidence of the extension of the flamelet regime beyond the Klimov-Wiliams criterion. Arguments based on the shape of the weighted joint probability distributions of axial velocity and temperature fluctuations show that the countergradient nature of heat flux is derived from large departures from the local mean values. The influence of swirl in strongly sheared disc-stabilised flames is analysed and the results obtained show that swirl attenuates the rate of turbulent heat transfer due to the decrease of the temperature gradients across the reacting zone, but does not alter the existence of a large zone of flame characterized by non-gradient scalar fluxes.
Author
Aerothermochemistry; Premixed Flames; Turbulent Wakes; Temperature Measurement; Velocity Measurement; Turbulent Flames; Baffles; Turbulent Combustion

19980206004 Instituto Superior Tecnico, Mechanical Engineering Dept., Lisbon, Portugal
THE SIMULTANEOUS MEASUREMENTS OF VELOCITY, PRESSURE, TEMPERATURE, AND HEAT RELEASE IN AN OSCILLATING FLAME
Fernandes, E. C., Instituto Superior Tecnico, Portugal; Heitor, M. V., Instituto Superior Tecnico, Portugal; Advanced Non-Intrusive Instrumentation for Propulsion Engines; May 1998; 12p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Optical and probe techniques are used for the analysis of the coupling mechanisms between pressure, velocity, and heat release fluctuations typical of pulsed flames, through the combination of laser velocimetry, digitally-compensated thermocouples, chemiluminiscent emissions of free radicals in the flames, and the pressure oscillations upstream flows. The results quantify the periodic nature of the mixing process and characterize the momentum and heat flux fluctuations along a cycle of oscillation.
Author
Pressure Oscillations; Turbulent Combustion; Pressure Measurement; Temperature Measurement; Velocity Measurement; Turbulent Flames; Flame Stability; Oscillating Flow

19980206010 Reading Univ., Dept. of Physics, United Kingdom
APPLICATION OF FTIR SPECTROSCOPY TO MEASUREMENT OF GAS TURBINE ENGINE EXHAUST EMISSIONS
Hilton, M., Reading Univ., UK; Lettington, A. H., Reading Univ., UK; May 1998; 6p; In English; See also 19980206002
Contract(s)/Grant(s): CEC-BRPR-CT96-0142; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Fourier Transform Infrared (FTIR) spectroscopy has been used to study the exhaust emissions from a static Rolls Royce Avon gas turbine engine. The thermal infrared emission from the hot exhaust gases was monitored non-intrusively from a distance of 5 meters using a high spectral resolution FTIR spectrometer fitted with a 16 cm aperture telescope. The gas temperatures were determined by comparing the intensity of the measured saturated CO2 emission band with the radiance of a black body radiation source at known temperatures. CO and CO2 gas concentrations were determined by comparison with modelled spectra taking into account instrument effects. The results were compared with earlier extractive gas analysis and non-intrusive measurements made on the same engine prior to its recent refurbishment. Improvements in the equipment used for non-intrusive measurements and in the analytical procedures have improved the sensitivity and the confidence with which such quantitative measurements may be made.
Author
Exhaust Emission; Gas Turbine Engines; Nonintrusive Measurement; Gas Temperature; Fourier Transformation; Infrared Spectroscopy; Gas Composition; Exhaust Gases

19980206042 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
OPTICAL DIAGNOSTICS FOR CRYOGENIC LIQUID PROPELLANTS COMBUSTION
Vingert, L., Office National d'Etudes et de Recherches Aerospatiales, France; Habiballah, M., Office National d'Etudes et de Recherches Aerospatiales, France; Gicquel, P., Office National d'Etudes et de Recherches Aerospatiales, France; Brisson, E., Office National d'Etudes et de Recherches Aerospatiales, France; Candel, S., Centre National de la Recherche Scientifique, France; Herding, G., Centre National de la Recherche Scientifique, France; Snyder, R., Centre National de la Recherche Scientifique, France; Scouflaire, P., Centre National de la Recherche Scientifique, France; Rolon, C., Centre National de la Recherche Scientifique, France; Stepowski, D., Centre National de la Recherche Scientifique, France; Cessou, A., Centre National de la Recherche Scientifique, France; Bazile, R., Centre National de la Recherche Scientifique, France; Colin, P., Centre National de la Recherche Scientifique, France; Guerre, S., Centre National de la Recherche Scientifique, France; Pealat, M., Office National d'Etudes et de Recherches Aerospatiales, France; Grisch, F., Office National d'Etudes et de Recherches Aerospatiales, France; Bouchardy, P., Office National d'Etudes et de Recherches Aerospatiales, France; May 1998; 12p; In English; See also 19980206002; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Detailed experimental studies of cryogenic propellant combustion are needed to improve design and optimization of high performance liquid rocket engines. A test facility called MASCOTTE has been built up by ONERA to study elementary processes (atomization, droplet vaporization, turbulent combustion...) that are involved in the combustion of liquid oxygen (LOX) and gaseous hydrogen (GH2). This article reports results from experiments carried-out on MASCOTTE under a consortium of laboratories and manufacturers associating ONERA, CNRS, CNES and SEP, on the jet flame issued from a single coaxial injector. This device fed with liquid oxygen and gaseous hydrogen is placed in a chamber equipped with quartz windows. The spray and the flame are observed with a set of optical methods: high speed cinematography, light emission from OH radicals, laser induced fluorescence of OH and O2, and elastic scattering from the LOX jet. These techniques are used to obtain images of the spray and of the flame zone. It is then possible to deduce the flame location with respect to the liquid jet from simultaneous elastic scattering of the LOX jet and LIF of OH measurements or from average emission images treated with Abel's transform. The images obtained by exciting the fluorescence of O2 provide complementary information on the flame shape and they may be used to estimate the local reaction rate. Quantitative temperature measurements based on Coherent Anti-Stokes Raman Scattering from H2 and LOX droplets size and velocity measurements by means of a Phase Doppler Particle Analyzer give additional clues on the spray and the combustion zone.
Author
Cryogenic Rocket Propellants; Liquid Propellant Rocket Engines; Propellant Combustion; Turbulent Combustion; Injectors; Optical Measuring Instruments; Liquid Rocket Propellants; Jet Flow; Liquid Oxygen; Hydrogen; Flames

19980206046 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. for Propulsion Technology, Cologne, Germany
USING THE LASER LIGHT SHEET TECHNIQUE IN COMBUSTION RESEARCH
Voigt, P., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Schodl, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A two dimensional Mie-Scattering technique has been optimised for concentration measurements inside isothermal mixing fields. A couple of corrections will be given, some of which concern the optical setup, others can only be computational. A detailed description of an algorithm for extinction correction is demonstrated for arbitrary particle distributions.
Author
Gas Mixtures; Turbulent Combustion; Concentration (Composition); Optical Measuring Instruments; Light Beams; Mie Scattering; Nonintrusive Measurement; Combustion Chambers

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METALLIC MATERIALS

19950017076 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
CORROSION DETECTION AND MANAGEMENT OF ADVANCED AIRFRAME MATERIALS *LA DETECTION DE LA CORROSION ET LA GESTON DES MATERIAUX AVANCES ENTRANT DANS LA CONSTRUCTION DES CELLULES*
Jan 1, 1995; 240p; In English; In French; 79th; Meeting of the AGARD Structures and Materials Panel, 5-6 Oct. 1994, Seville, Spain; See also 19950017077 through 19950017099
Report No.(s): AGARD-CP-565; AD-A292357; ISBN 92-836-1011-3; Copyright Waived; Avail: CASI; A11, Hardcopy; A03, Microfiche; Original contains color illustrations

A Specialists' Meeting on Corrosion Detection and Management of Advanced Airframe Materials was held to present the current knowledge base of corrosion, degradation, detection and prevention and to identify the research and development issues which must be addressed in order to ensure long service life and low maintenance costs of NATO aircraft. The Meeting concentrated on corrosion detection, test methodology for environmental assessment, mechanistic evaluation, corrosion prevention methods, and materials selection and design to prevent environmental degradation.
Airframe Materials; Conferences; Corrosion; Corrosion Prevention; Corrosion Tests

19950017077 Defence Research Agency, Structural Materials Centre., Farnborough, Hampshire, United Kingdom
THE CORROSION AND PROTECTION OF ADVANCED ALUMINIUM - LITHIUM AIRFRAME ALLOYS
Smith, C. J. E., Defence Research Agency, UK; Bartlett, D. L., Defence Research Agency, UK; Gray, J. A., Defence Research Agency, UK; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 9 p; In English; See also 19950017076; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The corrosion and stress corrosion cracking behavior of 8090-T81 and 2091-T84 sheet and 8090-T8171 plate aluminum-lithium alloys tested under laboratory and marine exposure conditions are compared with aerospace aluminium alloys currently in service. Initial results are also presented on the corrosion performance of a metal matrix composite aluminium alloy. The corrosion protection of aluminium-lithium alloys is discussed and progress on the development of chromate-free systems and their application to advanced aluminium alloys is described.
Author
Airframe Materials; Aluminum-Lithium Alloys; Corrosion; Corrosion Prevention; Exposure; Stress Corrosion Cracking

19950017078 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne, Germany
EXFOLIATION CORROSION AND STRESS CORROSION CRACKING BEHAVIOUR OF AL-LI ALLOYS
Braun, Reinhold, Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 12 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The exfoliation corrosion and stress corrosion cracking (SCC) behavior of damage tolerant sheet and plate materials of aluminum-lithium based alloys in underaged tempers was studied performing different accelerated tests. The EXCO test (ASTM G34) produced blistering and mild exfoliation corrosion. The modified EXCO test suggested by Lee and Lifka proved to be more severe than the standard EXCO test. When exposed to the cyclic acidified salt fog (MASTMAASIS test according to ASTM G85, Annex A2), the Al-Li alloys studied suffered severe exfoliation. The MASTMAASIS test reproduced marine exposure results for conventional 2024-T351 and 7075-T7351 plates and the limited data for aluminium-lithium based 8090-T81 and 2091-T84 sheets published in the literature. Therefore, it seems to be a promising testing technique to predict the service performance of high strength aluminum alloys. Static loading tests indicated very high SCC resistance for 8090-T8171 and 2091-T8X51 plates in longitudinal and long transverse directions. Environmentally assisted cracking occurred in the latter alloys when stress was applied

in the short transverse direction. Threshold stresses below 100 MPa were obtained from alternate immersion tests (ASTM G44) and from permanent immersion tests in an aqueous solution of 0.5 M NaCl plus 0.1 M LiCl plus 0.05 M NaHCO3 plus 0.05 M Na2CO3. Using the latter synthetic environment, the slow strain rate testing technique indicated sensitivity to stress corrosion cracking for recrystallized 8090-T81 and 2091-T84 sheet materials.
Author
Accelerated Life Tests; Aluminum-Lithium Alloys; Delaminating; High Strength Alloys; Load Tests; Strain Rate; Stress Corrosion Cracking; Weathering

19950017079 Middle East Technical Univ., Ankara, Turkey
EFFECT OF LOADING DIRECTION AND LONG-TERM AGING ON FATIGUE-CRACK GROWTH IN AL-LI ALLOY 2090
Anik, M., Middle East Technical Univ., Turkey; Doruk, M., Middle East Technical Univ., Turkey; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 9 p; In English; See also 19950017076; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The effect of prolonged exposures up to 1000 Hr at 150, 165 and 180 C on the fatigue-crack were studied in the Al-Li alloy 2090 using the direct current potential drop technique, and results compared with crack growth rates determined in salt water. The CCT specimens, 40 x 200 mm in size, were taken from the sheet material with a thickness of 1.6 mm. Since one of the purposes of this work was to investigate the directionality of fatigue-crack growth behavior, the specimens were machined in the grainflow direction (L-T), long-transverse direction (T-L) and 45 deg to rolling direction (L + 45 deg). The pretreatment applied before the aging consisted of solutionizing at 550 C for one hour followed by 6 percent stretching. According to the air results, the fatigue-crack behavior did not vary significantly with specimen orientations tested in this study. On the other hand, the long-term aging was found to have a pronounced effect on the crack growth kinetics, demonstrated by growth rates which increased up to about 8 fold following aging for 1000 Hr. The rate of the salt-water induced fatigue-crack growth was higher at low values, but lower at high values of Delta K, relative to those obtained in air. Whereas the reduction in roughness induced crack closure effect is believed to be responsible for enhancement at low stress intensity ranges the retardation at high Delta K-values may be attributed to crack-tip electrochemistry, whereby intermetallics with high cathodic efficiency are thought to play a role.
Author
Aging (Materials); Aluminum-Lithium Alloys; Crack Propagation; Exposure; Long Term Effects; Metal Fatigue

19950017080 Naval Air Warfare Center, Aircraft Div., Warminster, PA, United States
CORROSION OF LANDING GEAR STEELS
Lee, E. U., Naval Air Warfare Center, USA; Kozol, J., Naval Air Warfare Center, USA; Boodey, J. B., Naval Air Warfare Center, USA; Waldman, J., Naval Air Warfare Center, USA; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 12 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

A study was conducted on the corrosion behavior of landing gear steels, AerMet 100, 300M, AF1410, HYTUF and 4340. This study included investigations of stress corrosion cracking and immersion corrosion in an aqueous 3.5 percent NaCl solution, salt spray corrosion in a fog chamber of atomized aqueous 5 percent NaCl solution, humidity corrosion in an atmosphere of vapor from distilled water and hydrogen embrittlement. AF1410 steel is most resistant to stress corrosion cracking, and it is followed by AerMet 100, 0.20C AF1410, HYTUF, 300M and 4340 steels. The immersion corrosion and salt spray corrosion rates of an AerMet 100 steel are 33-40 percent and 13-20 percent those of a 300M steel. In a humidity chamber, AerMet 100 steel is not corrodible in 110 days, whereas 300M steel is quite susceptible to humidity corrosion. Compared to 300M steel, AerMet 100 steel is less susceptible to hydrogen embrittlement.
Author
Corrosion; Corrosion Tests; Humidity; Landing Gear; Salt Baths; Salt Spray Tests; Steels; Stress Corrosion Cracking

19950017081 KOMPOZIT Corp., Kaliningrad, Russia
SPECIFIC FEATURES OF CORROSION BEHAVIOR OF STAINLESS MARAGING STEELS FOR AEROSPACE APPLICATION
Spiridonov, V. B., KOMPOZIT Corp., Russia; Sharapov, V. V., KOMPOZIT Corp., Russia; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 4 p; In English; See also 19950017076; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Specific features of the embrittlement of stainless Cr-Ni maraging steels by environmental or N2O4 media are considered by the example of steel 03Kh11N10M2TU-VD. Results of corrosion tests and fractographic and microanalytical investigations are presented. The method of accelerated testing of these steels for stress corrosion cracking is described.
Author
Accelerated Life Tests; Corrosion; Corrosion Tests; Embrittlement; Maraging Steels; Stainless Steels; Stress Corrosion Cracking

19950017088 Belgian Center for Corrosion Study, Center for Corrosion Study., Brussels, Belgium
IN-SITU DETECTION OF SURFACE PASSIVATION OR ACTIVATION AND OF LOCALIZED CORROSION: EXPERIENCES AND PROSPECTIVES IN AIRCRAFT
Pourbaix, A., Belgian Center for Corrosion Study, Belgium; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 5 p; In English; See also 19950017076; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

The surveillance of the actual conditions of materials in aircrafts and the analysis of the influence of flight or standby conditions require detection methods that give quantitative and instantaneous results and that are related to the real degradation process. Electrochemical methods derived from methods used in laboratory have proven to be of interest. The scientific concepts and the instrumentation are generally easily applicable to field conditions; some effort is necessary to develop relevant sensors. The first example applies to the phosphating of carbon steels before painting. The characterization of surface passivation or reactivity can be of interest before and during the surface conversion processes. The second example applies to the detection of crevice corrosion, as may occur in riveted joints.
Author
Carbon Steels; Corrosion; Corrosion Resistance; Degradation; Detection; Electrochemistry; Passivity; Surface Reactions

19950017089 Belgian Center for Corrosion Study, Center for Corrosion Study., Brussels, Belgium
TEST METHOD AND TEST RESULTS FOR ENVIRONMENTAL ASSESSMENT OF AIRCRAFT MATERIALS
Pourbaix, A., Belgian Center for Corrosion Study, Belgium; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 4 p; In English; See also 19950017076
Contract(s)/Grant(s): DAJA45-83-C-0011; DAJA45-83-C-0041; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

A study was conducted to identify whether life prediction of high strength aluminum alloys for aircrafts can be determined from short term accelerated atmospheric corrosion tests. The method used is a wet and dry method with electrochemical measurements to characterize the formation or destruction of passive layers. The materials tested include high strength steel 4130, precipitation hardening 15-7 Mo-PH steel and aluminum alloys 6061, 7075 and 2024 with different heat treatments and surface conditions. It appears that the ranking of different Al alloys depends on the type of atmosphere (chloride or acid). The method also clearly showed the detrimental effect of chromated cadmium plating on the hydrogen embrittlement of high strength steel. Corrosion processes of aluminum and high strength steels were clearly identified and useful recommendations could be derived from such tests.
Author
Accelerated Life Tests; Aircraft Construction Materials; Aluminum Alloys; Atmospheric Effects; Corrosion; Corrosion Tests; Electrochemistry; High Strength Steels; Life (Durability)

19950017090 Deutsche Aerospace A.G., Munich, Germany
CORROSION PROTECTION MEASURES FOR CFC/METAL JOINTS OF FUEL INTEGRAL TANK STRUCTURES OF ADVANCED MILITARY AIRCRAFT
Hamm, Claus D., Deutsche Aerospace A.G., Germany; AGARD,

Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 11 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Assembly of carbon fiber composites (CFC) and aluminum structures shall be avoided in unprotected conditions. The more noble CFC could cause fatal galvanic corrosion on the aluminum part. Adequate protection methods for electrical isolation of these dissimilar materials shall be adopted. Adhesion of the coatings on both the CFC and aluminum substrate during exposure to the simulated fuel tank environment is an essential requirement for corrosion protection and fuel tightness of the joint. In a sequence of material and functional tests for selection of adequate coatings and associated materials as well as galvanic corrosion and integral tank aspects have been taken into account. Additional to the static panel test for paint adhesion corrosion tests under dynamic loading and corrosive environment were performed. Based on the experience of these investigations the selected combinations of the coatings, sealants and associated materials were applied on structural tank box for final evaluation. This test article represented the section of a fuselage integral fuel tank structure. For simulation of the complete in-service spectrum, during the life of an aircraft structure, static and dynamic loads were induced. The internal tank environment was simulated by water as fuel replacement and by pressurization of the compartment. Resistance of the CFC/aluminum joint to galvanic corrosion and liquid tightness of the selected integral tank concept proved excellent under simulated conditions.

Author

Adhesion Tests; Aluminum; Carbon Fibers; Corrosion Prevention; Corrosion Tests; Electrochemical Corrosion; Exposure; Fiber Composites; Protective Coatings; Static Tests

19950017091 Deutsche Airbus G.m.b.H., Bremen, Germany
CORROSION PREVENTION WITH ENVIRONMENTALLY COMPLIANT MATERIALS: A DESIGN CHALLENGE

Matz, C. W., Deutsche Airbus G.m.b.H., Germany; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 6 p; In English; See also 19950017076; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

In order to eliminate hazardous properties many well proven materials and processes for corrosion prevention have to be replaced. Examples are chromates in primers, sealants and pretreatment processes; and cadmium as plating material and solvents, which usage shall be significantly reduced. The replacement materials often do meet the usual requirements completely. Examples are given how the deficit in performance can be overcome by design changes and supplemental measures.

Author

Cadmium; Chromates; Corrosion Prevention; Hazards; Replacing

19950017095 Naval Air Warfare Center, Aircraft Div., Warminster, PA, United States
CORROSION DETECTION AND MONITORING OF AIRCRAFT STRUCTURES: AN OVERVIEW

Agarwala, V. S., Naval Air Warfare Center, USA; Bhagat, P. K., Federal Aviation Administration, USA; Hardy, G. L., Wright Lab., USA; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 6 p; In English; See also 19950017076; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Corrosion occurs on both military and civilian aircraft as a result of operation in corrosive environments and utilization of less than optimum corrosion preventive measures during fabrication. For low usage rate systems such as military aircraft, corrosion treatment constitutes a high cost maintenance action because corrosion effects can be life limiting mainly due to the fact that current techniques require extensive material loss for reliable detection of corrosion. For high usage systems such as commercial aircraft, corrosion may constitute a safety problem. A recent study by the U.S. Air Force at Tinker Air Force Base has demonstrated that while off-the-shelf nondestructive inspection equipment has some capability for detecting and quantifying aircraft corrosion, significant improvements in both detection and quantification are still required. Results of this study will be briefly reviewed along with discussions relating to some new and innovative inspection technology for detecting corrosion. New concepts and techniques for corrosion monitoring, i.e., detection of onset of corrosion or breakdown of corrosion protection system, will also be discussed. Advances in electrochemical measurements, thermal imaging, and optical scanning for chemical changes are providing some new research and development opportunities. Finally, concepts relating to damage-revealing chemicals and coatings which may revolutionize the detection and management of corrosion in our systems will be discussed.

Author

Aircraft Structures; Corrosion; Corrosion Prevention; Detection; Inspection; Safety Factors

19950017096 Deutsche Aerospace A.G., Munich, Germany
EXPERIENCE OF IN-SERVICE CORROSION ON MILITARY AIRCRAFT

Voss, H. J., Deutsche Aerospace A.G., Germany; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 18 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

To prevent corrosion of military aircraft the design has to be performed with respect to a careful material selection and an effective surface protection treatment of the materials. Protective treatment on aircraft against moisture, humidity, salty atmosphere, industrial environment, hydraulic fluids, fuel, de-icing fluids, combat chemicals etc. is necessary to meet the operation requirements of the aircraft throughout its operational life. Occurring corrosion detected during maintenance shows that not in every case the requirements above can avoid corrosion problems. This report will show some selected examples of in-service corrosion under investigation of the causes. Inspection and repair methods are shown; further recommendations for corrosion prevention and control to reduce corrosion problems based on practical experiences will be given.

Author

Aircraft Structures; Corrosion; Corrosion Prevention; Detection; Inspection; Surface Treatment

19950017097 Naval Air Station, Norfolk, VA, United States
US NAVY OPERATING EXPERIENCE WITH NEW AIRCRAFT CONSTRUCTION MATERIALS

Browne, G. T., Naval Air Station, USA; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 19 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper addresses the U.S. Navy's experience and problems encountered with new aircraft construction material in the highly corrosive naval operating environment, including: experience with carbon bismaleimide (BMI) and epoxy matrices composite, new aluminum alloys and metal to composite joint repair of honeycomb and monolithic composite structure in fleet activities ashore and afloat; problems experienced with electromagnetic interference (EMI) protection, systems currently in use, and the development of corrosion inhibiting conductive (EMI) sealant; and fastener compatibility for joining carbon composite to metals, H-60 and H-53 helicopter problems, and corrective actions.

Author

Aircraft Construction Materials; Aircraft Structures; Composite Structures; Corrosion; Corrosion Prevention; Corrosion Tests; Electromagnetic Interference; Matrix Materials

19950017098 Aerospatiale, Avions Div., Toulouse, France
CORROSION IN SERVICE EXPERIENCE WITH AIRCRAFT IN FRANCE

Frustie, M. J., Aerospatiale, France; Gauthier, P., CTMS, France; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 7 p; In French; See also 19950017076; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The objective of this communication is to present from a comparison of observed corrosions on modern airplanes (Airtbus, ATR) and corrosions on older airplanes (Transall, Caravelli) the progress realized in the control of corrosion, based on the adaption of materials and better performing protection. It's necessary today to adapt the techniques and constraints of the new legislative dispositions concerning the environment which bring to research the new materials and protection system.

Transl. by CASI

Coating; Corrosion; Corrosion Prevention; Environment Protection

19960021138 Army Research Lab., Cleveland, OH United States
AXIAL-TORSIONAL, THERMOMECHANICAL FATIGUE BEHAVIOR OF HAYNES 188 SUPERALLOY
Bonacuse, Peter J., Army Research Lab., USA; Kalluri, Sreeramesh, NYMA, Inc., USA; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 10p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The results of axial-torsional, thermomechanical fatigue experiments on thin walled tubular specimens fabricated from the wrought cobalt-base superalloy Haynes 188 are presented. The fatigue test matrix consists of uniaxial, thermally in-phase (maximum temperature coincides with the maximum mechanical strain) and thermally out-of-phase (maximum temperature coincides with the minimum mechanical strain) experiments; a torsional thermomechanical experiment; a mechanically in-phase (maximum axial mechanical strain occurs at the same point in time as the maximum torsional strain), thermally in-phase experiment; a mechanically in-phase, thermally out-of-phase experiment; a mechanically out-of-phase (maximum axial mechanical strain occurs when the torsional strain passes through zero), thermally in-phase experiment; and a mechanically out-of-phase, thermally out-of-phase experiment. In all the experiments the minimum temperature was 316 C and the maximum temperature was 760 C. The axial mechanical strain range in all experiments but the torsional experiment was 0.8%. The torsional strain range in all experiments with an axial strain component was 1.4%. Four multiaxial life models are used to predict the fatigue lives of these experiments. Using 760 C fatigue life parameters, derived from previous axial and torsional experiments on the same heat of Haynes 188, it was found that the von Mises equivalent strain range and Modified Multiaxiality factor approaches predicted the thermomechanical fatigue lives to within a factor of two of the experimentally observed fatigue lives for all experiments except for the thermally in-phase axial-torsional experiments. Predicted thermomechanical fatigue lives by the Smith-Watson-Topper and the Fatemi-Socie-Kurath parameters were also within a factor of two of the experimental observed fatigue lives, except for the mechanically out-of-phase tests. In general, the largest deviations from the experimentally observed lives were exhibited by the Fatemi-Socie-Kurath model.
Author
Torsion; Fatigue Life; Heat Resistant Alloys; Fatigue Tests; Thermal Fatigue; Axial Strain; High Temperature Tests; Cobalt Alloys; Mathematical Models; Performance Prediction

19970001700 Daimler-Benz Aerospace A.G., Military Aircraft, Munich, Germany
SHAPE MEMORY ALLOYS AND THEIR APPLICATION
Boller, Christian, Daimler-Benz Aerospace A.G., Germany; Brand, Werner, Daimler-Benz Aerospace A.G., Germany; Brinson, L. Catherine, Northwestern Univ., USA; Huang, Miin-Shiou, Northwestern Univ., USA; Oct. 1996; 14p; In English; See also 19970001697; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Shape memory alloys (SMA) have gained increasing attraction within the development of aircraft structures. One of the major reasons is, that they allow a recovery of deformation as a result of a transformation process between martensite and austenite, where transformation occurs between characteristic temperature values when being initiated by temperature. So far deformation capabilities of SMA's is mainly taken advantage of by using their two extreme conditions, such as clamped or loose for a fixing element. Continuous control of deformation during this transformation process however allows to take much more advantage of SMA's capabilities but this requires a clear description of the SMA's constitutive behavior which is actually an important area of research. The paper starts by analytically describing the SMA's constitutive behavior using an approach being well understandable for engineering applications. After having explained the basic mechanisms of SMA's it will be shown how these can be analytically implemented into the calculation process for determining the behavior of a simple engineering structure with an integrated SMA-actuator. Finally examples are described, where controlled deformation of a SMA in a smart structure is considered at present.
Author
Shape Memory Alloys; Smart Structures; Aircraft Structures

19970006812 Institute for Aerospace Research, Ottawa, Ontario Canada
AN INVESTIGATION ON SURFACE TREATMENTS FOR IMPROVING THE FRETTING FATIGUE RESISTANCE OF TITANIUM ALLOYS
Koul, A. K., Institute for Aerospace Research, Canada; Xue, L., Institute for Aerospace Research, Canada; Wallace, W., Institute for Aerospace Research, Canada; Bibby, M., Carleton Univ., Canada; Chakravarty, S., Hawker Siddeley Canada Ltd., Canada; Andrews, R. G., Hawker Siddeley Canada Ltd., Canada; Patnaik, P. C., Hawker Siddeley Canada Ltd., Canada; Tribology for Aerospace Systems; Oct. 1996; 10p; In English; See also 19970006808
Contract(s)/Grant(s): CRAD-FA-220791-NRC-51; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The effects of different surface modification treatments (shot peening, carbon and nitrogen ion implantation, CuNiIn soft coating, MoS2 solid lubricant and various combinations thereof) on the fretting fatigue resistance of Ti-6Al-4V and Ti-17 alloys have been investigated. Shot peening produces work hardening and compressive residual stresses in the surface layers, and shows the best improvement in the fretting fatigue life of both Ti-6Al-4V alloy at room temperature and Ti-17 alloy at 278 C. The application of a CuNiIn soft coating plus an overlay of MoS2 solid lubricant increases the fretting fatigue resistance of baseline Ti-6Al-4V and Ti-17 materials at room temperature and 278 C, respectively, by providing surface lubrication. However, the fretting fatigue life of shot peened plus CuNiIn and MoS(2) coated Ti-6Al-4V material appears to be vendor dependent and, in some cases, the fretting fatigue life is dramatically reduced after the application of a CuNiIn soft coating. This reduction in life may be attributed to the relaxation of compressive residual stresses in the shot peened layers by the plasma spraying process. Both carbon and nitrogen ion implantation improve the fretting fatigue life of baseline Ti-6Al-4V at room temperature. However, the application of carbon or nitrogen ion implantation significantly reduces the fretting fatigue resistance of shot peened specimens.
Author
Titanium Alloys; Metal Fatigue; Surface Treatment; Shot Peening; Solid Lubricants; Fretting; Protective Coatings; Fatigue Life; Ion Implantation

19970006819 Vanderbilt Univ., Dept. of Mechanical Engineering, Nashville, TN United States
ANALYSIS OF FRETTING AND FRETTING CORROSION IN AIRFRAME RIVETED CONNECTIONS
Iyer, K., Vanderbilt Univ., USA; Xue, M., Vanderbilt Univ., USA; Bastias, P. C., Vanderbilt Univ., USA; Rubin, C. A., Vanderbilt Univ., USA; Hahn, G. T., Vanderbilt Univ., USA; Tribology for Aerospace Systems; Oct. 1996; 12p; In English; See also 19970006808
Contract(s)/Grant(s): F49620-93-1-04888; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper examines the contributions of fretting and fretting corrosion to the deterioration of one-rivet low lap joints under cyclic loading. Two- and three-dimensional, finite element models of the riveted lap joint are used to define the joint distortion and compliance and to evaluate the mechanical parameters that govern fretting wear and fretting fatigue including the local stresses, cyclic slip amplitudes and corresponding contact pressures at the rivet-panel and panel-panel interfaces. Effects of rivet geometry and plasticity are examined. A piezoelectric fretting wear machine is used to reproduce the relevant contact pressures and slip amplitudes and to measure fretting wear rates for uncoated 2024-T3 and 7075-T6 aluminum sheet in contact with hardened steel and aluminum in relativity dry, laboratory air and 3.5% saline solution. The effects of slip amplitudes in the range 5 to 35 microns on the specific wear rate and coefficient of friction have been evaluated. Predictions based on the results of the modeling and fretting wear and fretting fatigue criteria are compared with experimental observations of cyclically loaded riveted connections.
Author
Fretting; Airframes; Riveted Joints; Lap Joints; Wear; Aluminum Alloys; Coefficient of Friction; Three Dimensional Models; Fretting Corrosion

19980137412 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
ALUMINUM ALLOY FORGINGS PROPERTY/PERFORMANCE ATTRIBUTES FOCUS: FATIGUE AND DURABILITY SERVICE CAPABILITIES ***LES PIECES FORGEES EN ALLIAGE D'ALUMINIUM LES ATTRIBUTS DE PERFORMANCE/CARACTERISTIQUES THEMES: FATIGUE ET DURABILITE CAPACITES EN SERVICE***
May 1998; 64p; In English
Report No.(s): AGARD-AR-353; ISBN 92-836-1074-1; Copyright Waived; Avail: CASI; A04, Hardcopy; A01, Microfiche

Historically, many aluminum aircraft components have been made from forgings. However, to reduce airframe manufacturing cost aircraft manufacturers are converting to parts machined from thick plate. The results of recent research indicates that forgings often offer significant advantages over components machined from plate. The purpose of this report is to present this information.
Author
Airframes; Aluminum Alloys; Loads (Forces); Fatigue (Materials); Durability; Forging; Aircraft Reliability

27 NONMETALLIC MATERIALS

19950017093 Air Products and Chemicals, Inc., Allentown, PA, United States
ORGANIC COATING TECHNOLOGY FOR THE PROTECTION OF AIRCRAFT AGAINST CORROSION
Hegedus, Charles R., Air Products and Chemicals, Inc., USA; Spadafora, Stephen J., Air Products and Chemicals, Inc., USA; Eng, Anthony T., Naval Air Warfare Center, USA; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 12 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche; Original contains color illustrations

Coating systems on military and commercial aircraft perform a variety of functions. Clearly, the most critical of these is the protection of aircraft structures from environmental degradation. Protective coatings serve as the primary defense against corrosion of aircraft metallic alloys, as well as degradation of other materials such as polymeric composites. Traditional coatings for aircraft include epoxy primers and polyurethane topcoats. Primers normally contain high concentrations of corrosion inhibitors, such as chromates, and they are designed to provide superior adhesion and corrosion protection. Polyurethane topcoats are formulated to enhance protection and durability; they also provide desired optical effects (i.e., anesthetics or camouflage). More recently, alternative coatings have been developed, such as self-priming topcoats, flexible primers, temporary and multi-functional coatings. These new developments reflect trends in protective coatings technology, changes in aircraft operational requirements/capabilities, and, most dramatically, concerns over environmental protection and worker safety. This issue has created a drive toward coatings with low (possibly zero) concentrations of volatile organic compounds (VOC's) and non-toxic corrosion inhibitors. In turn, these changes have led to concerns over long-term performance, especially protection against corrosion. This paper reviews current organic coatings technology for the protection of aircraft structures and discusses future needs and trends based on advancing technology, environmental concerns, and operational requirements.
Author
Aircraft Structures; Coating; Corrosion Prevention; Organic Materials; Primers (Coatings)

19970006809 Minho Univ., Dept. of Mechanical Engineering, Guimaraes, Portugal
TRIBOLOGICAL BEHAVIOUR OF SILICON NITRIDE-BASED CERAMICS
Gomes, J. R., Minho Univ., Portugal; Miranda, A. S., Minho Univ., Portugal; Silva, R. F., Aveiro Univ., Portugal; Vieira, J. M., Aveiro Univ., Portugal; Tribology for Aerospace Systems; Oct. 1996; 10p; In English; See also 19970006808
Contract(s)/Grant(s): ATRDA-C-CTM-607-92; Copyright Waived; Avail: CASI; A02, Hardcopy; A01, Microfiche

Engineering ceramics have enjoyed a growing technological interest in the last decades as high temperature, wear resistant materials. Their low density, low thermal expansion and high hardness associated with a high chemical and mechanical stability in a broad range of temperatures, make them superior candidates as alternative materials for cutting tool inserts, abrasion resistant components, automotive engine parts and aerospace vehicles. The tribological behavior of a Si3N4-based ceramic in sliding against tool steel and grey cast iron was investigated. The influence of environmental humidity, sliding speed and temperature on wear of the ceramic is presented and discussed. Laboratory tests were carried out in a pin-on-disc tribometer at variable environmental humidity ranging from 2% to 98%, sliding speed varying from 0.05 ms(exp -1) to 3.5 ms(exp -1), and disc temperatures in the range 22 C to 600 C. The wear mechanisms were investigated using scanning electron microscopy (SEM) with energy dispersive X-ray analysis (EDS). The formation of a tribolayer of wear debris adherent to the contact surface of the ceramic was found to be a determinant in keeping the wear coefficient low. The conditions leading to the formation of such protective layers are identified and discussed.
Author (revised)
Silicon Nitrides; Tribology; Ceramics; Wear Tests; Wear Resistance

19970006810 Wright Lab., Materials Directorate, Wright-Patterson AFB, OH United States
ADVANCED SOLID LUBRICANT COATINGS FOR AEROSPACE SYSTEMS
Zabinski, J. S., Wright Lab., USA; Prasad, S. V., Wright Lab., USA; McDevitt, N. T., Ramspec Research, USA; Tribology for Aerospace Systems; Oct. 1996; 12p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

Advances in solid lubricant technology are required for aerospace systems operating in extreme environments. Targeted operational temperature and lifetime requirements are beyond current capabilities. For example, to increase the thrust to weight ratio in expendable turbine engines, solid lubricants are under development for operation at temperatures to about 800 C. Increases in performance and lifetime for lubricated space based systems are also required. Technological advancements may be achieved through development of new coating materials, processes, and coatings strategies. New materials discussed in this report are oxides and adaptive lubricants. Adaptive lubricants undergo designed chemical reactions with the environment as temperature changes to continually maintain low friction and low wear. Pulsed laser deposition is discussed as an emerging process for growing solid lubricant thin films with complex chemistries and microstructures. Finally, multi-layer coatings that are under evaluation for improving adaptive lubricant performance are discussed.
Author
Solid Lubricants; High Temperature Lubricants; Lubrication; Ceramic Coatings; Pulsed Laser Deposition

19970006811 Wright Lab., Materials Directorate, Wright-Patterson AFB, OH United States
ADVANCED HARD COATINGS AND WEAR RESISTANT MATERIALS FOR AEROSPACE
Zabinski, J. S., Wright Lab., USA; Voevodin, A. A., Wright Lab., USA; Capano, M. A., Wright Lab., USA; Tribology for Aerospace Systems; Oct. 1996; 12p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Increasing demands placed on aerospace systems with respect to performance, lifetime, and operational environment have pushed lubrication and coatings technology to its limit. to meet increased demands, a number of hard, wear resistant coating materials and deposition processes are being developed. Discussion in this paper includes transition metal nitrides/carbides and diamond-like carbon (DLC). In particular, the use of these materials in multilayer and functionally gradient architectures as corrosion resistant, boundary lubricants for candidate high temperature turbine engine oils is highlighted. to effectively use new coating materials, processes that permit the growth of coatings at low temperature are required. This prevents loss

of dimensional tolerance and loss of mechanical properties of precision components. Several low temperature deposition processes are discussed, including a combined pulsed laser deposition - sputter source that permits the growth of infinitely variable gradients and sharp interfaces.
Author
Pulsed Laser Deposition; Protective Coatings; Ceramic Coatings; Functionally Gradient Materials; Titanium Nitrides; Titanium Carbides; High Temperature Lubricants; Solid Lubricants

19970006815 Dassault Aviation, Materials and Technologies, Saint-Cloud, France
SPUTTER-DEPOSITED LUBRICANT THIN FILMS OPERATING AT ELEVATED TEMPERATURES IN AIR
Zimmermann, C., Dassault Aviation, France; Paulleau, Yves, Commissariat a l'Energie Atomique, France; Tribology for Aerospace Systems; Oct. 1996; 8p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

For the lubrication of sliding contacts operating in hostile environments (vacuum, high temperatures, corrosive ambient, etc.), for which liquid lubricants are ineffective or undesirable, solid lubricant coatings are needed to reduce friction and wear in order to prevent damage. Many solutions such as soft metals (Ag,Pb), lamellar compounds (MoS2), polymers, and graphite fluoride have been proposed in the last decade. The plasma-sprayed composite PS212 developed by NASA is known as a reference. This thick coating (about 150 microns) is a matrix of metal-bonded chromium carbide (Cr3C2) for wear control at high temperatures (800 C) mixed with silver and alkaline earth metal fluorides for the lubrication at respectively low and high temperature. However major drawbacks of these thick coatings are essentially related to its thickness and its roughness; a diamond grinding operation is necessary to adjust the thickness and to improve the surface quality required for a sliding contact. This operation is not easy in small size parts and in ball bearings. The high level of temperature (up to 700 C) required by the spherical bearings of the space shuttle HERMES control surfaces associated with a low friction coefficient (less than 0,3) has needed a specific development. DASSAULT in collaboration with the CENG and ISMCM has developed and tested an innovative thin coating, based on the same compounds as those of the PS212, deposited by a radio frequency sputtering process. A specific test mean, able to conduct tests on spherical bearings under representative conditions of a reentry (temperature, pressure, high load and oscillatory motion) has also been developed.
Author (revised)
Thin Films; Solid Lubricants; Sprayed Coatings; Sputtering; Ball Bearings; Chromium Carbides; Calcium Fluorides; Coefficient of Friction; High Temperature Lubricants

19970006817 Daimler-Benz Aerospace A.G., Military Aircraft, Munich, Germany
METALLIC AND NON-METALLIC PROTECTION SYSTEMS FOR REDUCTION OF TRIBOLOGIC INFLUENCES IN SEVERAL AREAS ON TORNADO AIRCRAFT
Hamm, C. D., Daimler-Benz Aerospace A.G., Germany; Blomeier, K., Daimler-Benz Aerospace A.G., Germany; Tribology for Aerospace Systems; Oct. 1996; 12p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The TORNADO multi-role combat aircraft was designed in the 1970's and went into service at the beginning of 1980. From this time up to now several aircraft have achieved approximately 3000 flight hours. With respect to its operational role the TORNADO has been designed as a swept wing aircraft. This type of aircraft with variable wing sweep capability includes in principle more areas which are subjected to sliding and wear than a fixed wing aircraft. Due to this design the affected interfaces of different structural materials have been protected with adequate coatings or materials to maintain the operability of the aircraft. Depending on the function of the movable joints on the aircraft structure, metallic and non-metallic coatings/ materials with adequate hardness and wear resistance have been adopted. The range of applied antiwear coatings comprises silver plating against fretting corrosion, abrasion resistant polymers, etc. This paper describes the application of adequate protection methods in view of their functional integrity in the aircraft structure. Longterm experiences during service life and repairability aspects are discussed.
Author (revised)
MRCA Aircraft; Military Aircraft; Tribology; Protective Coatings; Aircraft Construction Materials; Metal Coatings; Wear Inhibitors

19970019671 Centre de Recherches Scientifiques et Techniques de l'Industrie des Fabrications Metalliques, Parc Scientifique de la Cense Rouge, Brussels, Belgium
THE ASSEMBLY OF THERMOPLASTICS BY ADHESIVE BONDING: PROCESS AND CONTROL
Lecomte, J., Centre de Recherches Scientifiques et Techniques de l'Industrie des Fabrications Metalliques, Belgium; Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 8p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Nowadays, the manufacturing techniques include more and more frequently the assembling of different materials, each dedicated to fulfill one or several requirements of the final assembly. Product designers are therefore induced to consider adhesive bonding of thermoplastic materials, either between themselves or to other materials. Adhesive bonding offers several advantages: weight reduction, better stress distribution in the joint, sealing and insulation. However, this type of assembly, especially when the adherents are thermoplastics, raises many questions about the performances in terms of mechanical resistance, durability, and also about the reliability and the control of the joints. This presentation will consider the four design steps which are of primary importance for the conception of an assembly by adhesive bonding.
Author
Adhesive Bonding; Thermoplastic Resins; Thermoplasticity

19970019676 NASA Lewis Research Center, Cleveland, OH United States
PROBABILISTIC EVALUATION OF BOLTED JOINTS IN POLYMER MATRIX COMPOSITES
Chamis, C. C., NASA Lewis Research Center, USA; Minnetyan, L., Clarkson Univ., USA; Jan. 1997; 16p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Computational methods are described to probabilistically simulate fracture in bolted composite structures. Progressive fracture is simulated via an innovative approach independent of stress intensity factors and fracture toughness. The effect on structure damage of design variable uncertainties is quantified. The Fast Probability Integrator is used to assess the scatter in the composite structure response before and after damage. Sensitivity of the response to design variables is evaluated. The methods are demonstrated for bolted joint polymer matrix composite panels under end loads. The effects of fabrication process are included in the simulation of damage in the bolted panel. The results show that the most effective way to reduce the end displacement at fracture is to control the load and ply thickness.
Author
Bolted Joints; Composite Structures; Fracture Strength; Stress Intensity Factors; Polymer Matrix Composites

19970023085 Defence Research Agency, Structural Materials Centre, Farnborough, United Kingdom
RESEARCH INTO CHROMATE-FREE TREATMENTS FOR THE PROTECTION OF ALUMINIUM ALLOYS
Smith, C. J., Defence Research Agency, UK; Baldwin, K. R., Defence Research Agency, UK; Evans, V. M., Defence Research Agency, UK; Garrett, S. A., Defence Research Agency, UK; Smith, K. S., Defence Research Agency, UK; Feb. 1997; 10p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Chromate based pretreatments and chromate pigmented primers are extensively used in the corrosion protection of aerospace aluminum alloys. Current design requirements for UK military aircraft specify the use of either a chromate conversion coating or a chromic acid anodizing treatment on components manufactured from aluminum alloys. This is followed with the application of an epoxy primer containing a strontium chromate inhibitive pigment. Because of concern about the carcinogenic nature of chromates, a research

program to develop non-chromate pretreatments and protective finishes has been undertaken. The results of research into novel inhibitors for aluminum alloys and their application to pretreatments and aircraft primers are presented. Several promising inhibitors including cerium salts, sulphur containing compounds and oxoanions have been identified. Whilst none of the systems so far investigated give the same level of protection as chromate based treatments, progress towards a chromate-free protection scheme is being made.
Author
Aluminum Alloys; Surface Treatment; Pretreatment; Corrosion Prevention; Inhibitors; Environment Protection; Research

19970023087 Wright Lab., Wright-Patterson AFB, OH United States
ADVANCED SURFACE PREPARATION FOR METAL ALLOYS
Mazza, James J., Wright Lab., USA; Feb. 1997; 12p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Current metal surface preparation processes typically rely on materials that are undesirable from environmental or safety perspectives, such as strong acids/bases and hexavalent chromium. In addition, these processes usually produce large wastewater streams. The USA Air Force (USAF) Wright Laboratory is investigating alternate surface preparation approaches in order to develop and transition processes that are environmentally friendly with equal or improved performance. Several technologies are being evaluated, primarily for adhesive bonding of aluminum and titanium. These include: excimer laser, plasma polymerization, ion beam enhanced deposition, plasma spray and sol-gel. These approaches eliminate or greatly reduce the undesirable environmental impact of the currently-approved processes. Most of the candidates deliver bond strength performance equivalent to these existing procedures. As measured by accelerated laboratory testing, none consistently provide the long-term moisture durability of the state-of-the-art. However, some candidates outperform existing, accepted processes and appear to be capable of delivering state-of-the-art moisture durability once optimized. At this time, sol-gel provides the best combination of performance and ease of scale-up for depot and field applications. With this approach, a water-based solution is applied to the metal and dried at elevated temperature without rinsing. Environmentally friendly pretreatment (cleaning and deoxidizing) and post-treatment (priming) steps are used. Future work will continue optimization and scale-up efforts for solgel and other viable candidates. Transition to USAF and other users will be pursued. High-temperature titanium bonding and on-aircraft aluminum bonding are potential early transition opportunities.
Author
Metal Surfaces; Environment Protection; Aluminum Alloys; Titanium Alloys; Pretreatment; Sol-Gel Processes

19970023094 AVRO International Aerospace, Post Station 38, Woodford, United Kingdom
QUALIFICATION OF CHROMATE-FREE PRIMERS FOR APPLICATION TO AIRCRAFT STRUCTURE
Higgins, A., AVRO International Aerospace, UK; Feb. 1997; 10p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Paint primers used on metallic aircraft structure are the major contributing element in the protection of the structure against corrosion. Qualification testing of primers for use on aircraft structure is therefore aimed at assessing if adequate service performance can be achieved. All assessors use accelerated degradation testing based on long term immersion in fluids to which the aircraft structure will be subjected in service, thermal cycling, exposure to high humidity and various corrosion tests. Accelerated corrosion testing is the primary method used in most qualification specifications for assessing service life expectancy of the primed metallic surface. The variability of service conditions and the lack of precise data of service life to corrosion test performance make this assessment subjective. The general performance of chromated primers in service can be used to compare respective accelerated corrosion test performance of alternative primers. Consideration needs to be given to the fact that chromated primers are capable of protecting structure for well past the airframe service life in most areas. This means that chromate-free alternatives with lower accelerated test performance could be considered for areas of the structure where the performance in service is assessed to be adequate. The variation in approach to assessment and in the test methods used by different airframe manufacturers and those called up in national specifications needs to be rationalized and better defined if the primer manufacturers are to be able to provide the airframe industry with a suitable chromate-free alternative primer.
Author
Aircraft Structures; Accelerated Life Tests; Corrosion Tests; Metal Surfaces; Primers (Coatings); Paints; Environment Protection

19980197432 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
THERMAL BARRIER COATINGS *LES REVETEMENTS ANTI-MUR DE CHALEUR*
Apr. 1998; 188p; In English; See also 19980197433 through 19980197449
Report No.(s): AGARD-R-823; AD-A344715; ISBN 92-836-1073-3; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

Thermal barrier coatings are an emerging technology which will allow either increasing the inlet turbine temperatures or on the other hand decreasing the working temperature of the metal of the blades and consequently increasing their life-time. The Workshop allowed a survey of the state of the art, a description of the existing technologies or of the technologies under development, a review of the present knowledge of damage mechanisms, including microstructural, mechanical and thermal aspects, and an account of the advantages and drawbacks of the various families as perceived by engine manufacturers and users. A final discussion was held to identify the needs for further R & D.
Author
Thermal Control Coatings; Engine Parts; Protective Coatings; Ceramic Coatings; Temperature Gradients; Aircraft Engines; Plasma Spraying; Vapor Deposition; Engine Inlets; Inlet Temperature; Temperature Control

19980197433 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Materials and Process Dept., Villaroche, France
THERMAL BARRIER COATINGS: THE THERMAL CONDUCTIVITY CHALLENGE
Alperine, S., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Derrien, M., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Jaslier, Y., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Mevrel, R., Office National d'Etudes et de Recherches Aerospatiales, France; Thermal Barrier Coatings; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

In this paper, the importance of the challenge associated with the control of the thermal conductivity of thermal barrier coatings for turbine engines hot stages is being reviewed (yttria stabilised zirconia mostly). It is firstly illustrated by the description of a practical aeronautic coated and uncoated turbine blade design exercise. The various contributions to TBC thermal conductivity are then reviewed. Their low conductivity finds its source not only in the nature of the ceramic layer (highly disordered material), but also in the morphology of the insulating layer, closely linked to its fabrication process parameters. The influence of various factors (such as yttria content, temperature, porosity content and distribution, etc.) on the thermal conductivity is examined, largely based on a literature review. In this field of investigation, the modelling tool should allow to predict, to a certain extent, which morphology would lead to the lowest values of thermal conductivity. Eventually attempts are made to identify research domains where further understanding is needed, and to formulate several suggestions concerning possible ways to lower the thermal conductivity.
Author
Thermal Control Coatings; Yttria-Stabilized Zirconia; Turbine Engines; Turbine Blades; Thermal Conductivity; Fabrication; Protective Coatings; Ceramic Coatings; Heat Transfer; Temperature Control

19980197434 Limoges Univ., Faculte des Sciences, France
RECENT DEVELOPMENTS IN PLASMA SPRAYED THERMAL BARRIER COATINGS
Fauchais, P., Limoges Univ., France; Vardelle, A., Limoges Univ., France; Vardelle, M., Limoges Univ., France; Thermal Barrier Coatings; Apr. 1998; 12p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A03, Hardcopy; A10, Microfiche

This paper presents a review of our present knowledge in the formation of plasma sprayed Thermal Barrier Coatings (TBCs). The

following points are examined for TBCs made of zirconia partially stabilized with 8 wt % of yttria: (1) Characteristic times for particle flattening, splat cooling, and solidification with the corresponding cooling rates and microstructure. (2) Critical preheating temperature of substrates or previously deposited layers to achieve a good contact with splats. An explanation of the effect of this critical temperature is proposed. (3) Times between two impact events at the same location and two successive passes. The consequences on the mean temperature within coating in conjunction are underlined for various substrate and coating cooling devices. (3) The effect of substrate critical temperature and substrate oxidation stage on coating adhesion/ cohesion. (4) Splat layering and temperature conditions at which a columnar structure can grow through the whole coating. The consequences on stresses development during and after spraying and coating Young's modulus, are discussed. (5) At last, the parameters which have to be controlled during spraying to achieve a much better reproducibility of coatings. A special emphasize is given to torch voltage fluctuations related to electrodes erosion, powder injection conditions and finally substrate and coating temperature before (preheating) during and after (cooling) spraying.
Author
Thermal Control Coatings; Plasma Spraying; Sprayed Coatings; Protective Coatings; Yttria-Stabilized Zirconia; Mechanical Properties; Turbine Blades; Temperature Control

19980197435 National Research Council of Canada, Industrial Materials Inst., Boucherville, Quebec Canada
IN-FLIGHT PARTICLE DIAGNOSTICS FOR ON-LINE PROCESS CONTROL DURING DEPOSITION OF PLASMA-SPRAYED TBCS
Moreau, C., National Research Council of Canada, Canada; Gougeon, P., National Research Council of Canada, Canada; Prystay, M., National Research Council of Canada, Canada; Leblanc, L., National Research Council of Canada, Canada; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

Plasma-sprayed TBCs are built by the successive addition of molten or partially-molten particles spreading upon impact on the substrate surface. Consequently, the temperature and velocity of the sprayed particles are among the most important parameters influencing the microstructure and properties of the deposited coatings. On-line measurement of these parameters, as well as the particle trajectories, is thus an efficient way to monitor the state of the spray process. This approach should permits to minimize the influence of uncontrolled parameters such as the electrode wear or changes in particle injection conditions. A rugged and easy-to-use optical sensor system has been developed to perform on-line particle diagnosis during spraying in a production environment. In this system, the thermal radiation emitted by the in-flight particles is collected by a compact sensing head and transmitted through an optical fiber bundle to a detection cabinet located away from the dusty environment around the plasma torch . In this paper, a review of some applications of this diagnosis system used to determine the influence of the spray parameters on the particle temperature, velocity and trajectory and to control the spray process during deposition of TBCs are presented. The system was used in production at Pratt & Whitney Canada (PWC) for two months giving information about the stability and reproducibility of the plasma spray process.
Author
Thermal Control Coatings; Plasma Spraying; Sprayed Coatings; Protective Coatings; Deposition; Spray Characteristics; Sprayers

19980197436 BMW Rolls-Royce Aeroengines G.m.b.H., Material Technology, Oberursel, Germany
ON THICK THERMAL BARRIERS FOR COMBUSTOR APPLICATION
Haubold, T., BMW Rolls-Royce Aeroengines G.m.b.H., Germany; Gans, H., BMW Rolls-Royce Aeroengines G.m.b.H., Germany; Schwingel, D., Manchester Univ., UK; Taylor, R., Manchester Univ., UK; Apr. 1998; 8p; In English; See also 19980197432
Contract(s)/Grant(s): CEC-BRE2-CT94-0936; BMBF-0326760B; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

Basic features for future advanced gas turbines will be low emission rates and increased efficiency. to fulfil these requirements a reduction of cooling air in the combustor chamber demanding more efficient cooling technology and/or an development inner wall temperature is needed. The development of thicker thermal barrier coatings for combustor tile applications is one concept followed to enable a reduction in cooling air. Thermal barrier coatings with a thickness up to 2mm and improved thermal cycling life have been developed as well as mechanical and thermophysical data determined. Combustor segment rig testing demonstrated a potential of 25% cooling air reduction by the use of thick thermal barrier for the tile design investigated.
Author
Thermal Control Coatings; Combustion Chambers; Gas Turbines; Cooling; Protective Coatings; Heat Resistant Alloys; Ceramic Matrix Composites

19980197437 Cranfield Univ., Bedford, United Kingdom
ADVANCED PROCESSING OF TBC'S FOR REDUCED THERMAL CONDUCTIVITY
Nicholls, J. R., Cranfield Univ., UK; Lawson, K. J., Cranfield Univ., UK; Rickerby, D. S., Rolls-Royce Ltd., UK; Morrell, P., Rolls-Royce Ltd., UK; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

Zirconia-8wt% yttria thermal barrier coatings (TBC's) provide the potential to increase the operating temperatures within the modern aeroengine gas turbine. of particular interest are the columnar, strain tolerant thermal barriers produced by electron beam physical vapour deposition which can be applied to rotating components and can reduce the metal surface temperature by up to 150 C. Measured thermal conductivities for this columnar microstructure are typically 1.8-2.0 W/m.K. Should it be possible to reduce this value to that observed for plasma sprayed ceramics (0.9-1.0 W/m.K) then further benefits from the use of such a ceramic layer could ensue including either a further increase in operating temperature or a reduction in cooling air requirements. This paper examines the advanced processing of TBC's with the aim of reducing thermal conductivity. The role of coating thickness is reviewed, where it is shown that for thin coatings, circa 100 micro-m thermal conductivities of 1.0 W/m.K can be achieved. This is thought to be due to increased scattering of thermal waves close to the early confused growth region. The possibility of further reducing thermal conductivity by using layered structures is examined. These structures have been manufactured by control of rotation, controlled dwell and through the use of plasma assistance during the deposition process. The benefits of such layers in scattering thermal waves is discussed.
Author
Thermal Control Coatings; Thermal Conductivity; Yttrium Oxides; Zirconium Oxides; Gas Turbines; Operating Temperature; Vapor Deposition; Protective Coatings; Heat Transfer

19980197438 PyroGenesis, Inc., Montreal, Quebec Canada
TBCS ON FREE-STANDING MULTILAYER COMPONENTS
Tsantrizos, P. G., PyroGenesis, Inc., Canada; Kim, G. E., PyroGenesis, Inc., Canada; Brzezinski, T. A., PyroGenesis, Inc., Canada; Apr. 1998; 8p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

PyroGenesis Inc. has developed a unique process for the production of components designed to operate in the hot section of gas turbines. The new process involves spray forming multilayer components by Vacuum Plasma Spraying (VPS) onto molds and subsequently separating the mold from the near net-shape free-standing component. Advanced TBCs have been developed and incorporated into the multilayer structure in an effort to extend the component's high temperature performance capabilities. The spray formed components are heat treated to improve the mechanical properties of the superalloys. PyroGenesis has used the VPS near net-shape forming process to fabricate closed components with a TBC inner layer, consisting of calcia silica (Ca2SiO4) and zirconia partially stabilized with yttria (PSZ), a CoNiCrAlY bond coat, and an IN-738LC outer layer. Preliminary results indicate that the spray formed components have excellent mechanical properties, can operate at much higher temperatures than similar conventionally fabricated components and require less cooling. The TBCs showed uniform thickness and microstructure with a smooth surface finish. The bond coat and structural superalloy layers were very dense with no signs of oxidation at the interface. After heat

treatment, the mechanical properties of the IN-738LC compare favourably to cast materials. Finally, the cost of spray forming multilayer components is lower than the cost of conventional fabricating options. Author

Thermal Control Coatings; Plasma Spraying; Heat Resistant Alloys; Fabrication; Gas Turbines; Engine Parts; Surface Finishing; Sprayed Coatings

19980197439 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Materials and Processes Dept., Moissy-Cramayel, France

ELECTRON BEAM PHYSICAL VAPOUR DEPOSITION THERMAL BARRIER COATINGS: A COMPARATIVE EVALUATION OF COMPETING DEPOSITION TECHNOLOGIES

Jaslier, Y., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Alperine, S., Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, France; Apr. 1998; 10p; In English; See also 19980197432; Sponsored in part by SPAE; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

The need for improving the performance and maintenance costs of gas turbine engines has led to the development of advanced thermal protection systems for critical components such as high pressure turbine (HPT) blades and vanes. This led to the concomitant development of advanced coating deposition techniques. Electron beam physical vapour deposition (EB-PVD) first made possible the application of corrosion resistant overlay coatings on turbine blades. The EB-PVD technology has since been gaining ever more interest world-wide as it stands as the best industrial technique for the deposition of thermal barrier coatings on first stage HPT aerofoils. The strategic nature of the EB-PVD process means that it has been developing somewhat independently on both sides of the iron curtain during the cold war years. Today, both American and ex-USSR technologies are open to the market. This is the object of this paper to compare the two state-of-the-arts both from a deposition process standpoint and from a laboratory evaluation on samples. This evaluation covers structural studies as well as thermal cycling testing. The relationship between the deposition process and the coating functional behaviour is discussed.
Author

Thermal Control Coatings; Vanes; Turbine Blades; Protective Coatings; Electron Beams; Vapor Deposition

19980197440 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Materials Research, Cologne, Germany

PROCESSING, CHARACTERISATION, AND TESTING OF EB-PVD THERMAL BARRIER COATINGS

Kaysser, W. A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Peters, M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Fritscher, K., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Schulz, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

Thermal barrier coatings (TBCs) are increasingly applied to hot components in gas turbines. Contrary to plasma spraying, the electron-beam physical vapour deposition (EB-PVD) process offers the opportunity to generate coatings having a unique columnar microstructure. The main advantage of this structure is its superior tolerance against straining and thermoshock, thus giving it a major edge in lifetime. Furthermore, cooling hole closure will be prevented and the aerodynamic design of the blades will be maintained. This paper will outline the advantages of EB-PVD for the production of TBCs on rotating gas turbine components like blades and vanes. The effect of EBPVD processing parameters on the microstructural evolution and respective lifetimes of partially yttria stabilised zirconia (PYSZ) TBCs will highlight the potential of the evaporation process. Alternative stabilisers like Ce and La are looked at in terms of increase of application temperatures as well as life extension of the blades. An extended structural zone diagram for PVDis proposed incorporating the influence of substrate rotation on microstructural evolution. Finally, the limits of evaporation processing will be stressed.
Author

Thermal Control Coatings; Yttria-Stabilized Zirconia; Electron Beams; Vapor Deposition; Protective Coatings; Engine Parts; Gas Turbine Engines; Surface Properties

19980197441 Office National d'Etudes et de Recherches Aerospatiales, Materials Science Dept., Paris, France

PLASMA ASSISTED CVD OF THICK YTTRIA PARTIALLY STABILIZED ZIRCONIA COATINGS

Chevillard, S., Office National d'Etudes et de Recherches Aerospatiales, France; Drawin, S., Office National d'Etudes et de Recherches Aerospatiales, France; Vidal-Setif, M. H., Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

Plasma-assisted chemical vapor deposition has been successfully used to deposit thick (20 - 150 micron) zirconia - (5-20wt%) yttria coatings on metallic and alumina substrates, with high rates (up to 150 micro-m/h) at temperatures ranging from 400 to 750 C. Tetrachloride (ZrC14) and Y(thd)3 beta-diketonate were used as zirconium and yttrium source materials. Vaporization conditions have been studied for both precursors. Morphology, impurity content, and crystallographic structure of the coatings were investigated. At all deposition temperatures, the coatings exhibited columnar morphology and {100} crystallographic texture. At low substrate temperature (400 C), the pore volume fraction was high (ca. 50%) and the coatings incorporated some carbon and chlorine impurities, but at high temperature (750 C), the pore fraction reduced to about 25% and little carbon and no chlorine were detected. Metastable tetragonal <t'>> phase was the main constituent of coatings with 7 and 10wt% yttria. Annealing for 24 and 120 hours of ZrO2 - 7wt% Y2O3 coating deposited at 400 C showed that cubic phase with an yttria content of about llwt% is allowed to form, at the expense of the <t'>> phase whose yttria content diminishes to 4wt%. This relatively fast evolution towards thermodynamic equilibrium may be related to the high porosity level.
Author

Thermal Control Coatings; Yttria-Stabilized Zirconia; Vapor Deposition; Heat Resistant Alloys; Protective Coatings

19980197442 Office of Naval Research, Materials Div., Arlington, VA United States

THERMAL SPRAYED NANOSTRUCTURED THERMAL BARRIER COATINGS

Kabacoff, L. T., Office of Naval Research, USA; Apr. 1998; 8p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

Nanostructured ceramics exhibit a number of enhanced mechanical and thermal properties which may make them attractive as thermal barrier coatings. The phonon contribution to thermal conductivity is greatly reduced at room temperature, but becomes significant at operating temperatures only for grain sizes below 20 nm. Improvements in mechanical properties such as fracture toughness and resistance to spalling, can be achieved at larger grain size. in the range of 30 - 70 nm. Suitable coatings, consisting of a composite of zirconia with a second immiscible phase, such as alumina, can be fabricated by thermal spray. However, development of techniques to produce the required microstructure are at an early stage and may require advances in the state of the art for thermal spray technology.
Author

Thermal Control Coatings; Sprayed Coatings; Mechanical Properties; Nanocrystals; Grain Size; Thermal Conductivity; Fabrication; Ceramics; Microstructure

19980197443 Office National d'Etudes et de Recherches Aerospatiales, Materials Science Dept., Paris, France

MODELLING THE THERMAL CONDUCTIVITY OF THERMAL BARRIER COATINGS

Dorvaux, J.-M., Office National d'Etudes et de Recherches Aerospatiales, France; Lavigne, O., Office National d'Etudes et de Recherches Aerospatiales, France; Mevrel, R., Office National d'Etudes et de Recherches Aerospatiales, France; Poulain, M., Office National d'Etudes et de Recherches Aerospatiales, France; Renollet, Y., Office National d'Etudes et de Recherches Aerospatiales, France; Rio, C., Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

The thermal conductivity of ceramic coatings is a function of the thermal conductivity of the individual constituents (nature of phases, presence of point and planar defects, etc.) and of the morphology of the coating (pores, cracks). This latter aspect is particularly important for TBCs as it explains why their thermal conductivity is significantly

lower than the corresponding values for dense materials. This paper presents a model developed to calculate the thermal conductivity of porous and microcracked ceramic coatings based on a finite difference method applied on digitized images of yttria partially stabilised zirconia (YPSZ) coatings deposited by plasma spraying. The influence of the different types of morphological features on the thermal conductivity is discussed.
Author
Thermal Control Coatings; Yttria-Stabilized Zirconia; Finite Difference Theory; Ceramic Coatings; Thermal Conductivity; Cracks; Porosity; Models; Plasma Spraying

19980197444 Utah Univ., Dept. of Metallurgical Engineering, Salt Lake City, UT United States
MICROSTRUCTURE AND THERMAL CONDUCTIVITY OF LAYERED THERMAL BARRIER COATINGS PROCESSED BY PLASMA SPRAY AND PHYSICAL VAPOR DEPOSITION TECHNIQUES
Ravichandran, K. S., Utah Univ., USA; An, K., Utah Univ., USA; Dutton, R. E., Wright Lab., USA; Semiatin, S. L., Wright Lab., USA; Apr. 1998; 12p; In English; See also 19980197432
Contract(s)/Grant(s): F33615-92-C-5900; Copyright Waived; Avail: CASI; A03, Hardcopy; A10, Microfiche

Thermal conductivity is an important design parameter for thermal barrier coatings. Accurate thermal conductivity data is therefore required to ensure proper design and reliability of gas turbine blades. In the present research, thermal conductivities of Al2O3 and 8wt.% Y2O3 stabilized ZrO2 (8YSZ) coatings, including monolithic and multilayer configurations, made by air plasma spray (PS) and electron beam physical vapor deposition (EB-PVD) techniques, were determined from the measurements of thermal diffusivity and specific heat as a function of temperature. Thermal diffusivity was determined by the laser flash technique. Specific heat was determined by a Differential Scanning Calorimeter (DSC). Detailed analyses of the results indicate that in the case of PS coatings, the thermal conductivity is sensitive to coating density (porosity), interfaces between splats as well as the interface between the coating and the substrate. In the case of EBPVD coatings, it is shown that the multilayer conductivity is simply a series representation of monolithic coatings, provided comparisons are made under same microstructural condition. Further, analyses of sensitivity of the laser flash technique to variations in the coating and the substrate parameters, for the coatings evaluated in this study, were also performed. The results are discussed in the context of coating characteristics, reference conductivity data for dense materials and the sensitivity of the measurement method to coating parameters.
Author
Thermal Conductivity; Thermal Control Coatings; Microstructure; Yttria-Stabilized Zirconia; Aluminum Oxides; Electron Beams; Vapor Deposition; Plasma Spraying; Turbine Blades; Protective Coatings

19980197445 Institute for Aerospace Research, Ottawa, Ontario Canada
EVALUATION OF THERMAL BARRIER COATINGS FROM BURNER RIG TESTS
Immarigeon, J.-P., Institute for Aerospace Research, Canada; Parameswaran, V. R., Institute for Aerospace Research, Canada; Chow, D., Institute for Aerospace Research, Canada; Morphy, D. D., Institute for Aerospace Research, Canada; Gougeon, P., National Research Council of Canada, Canada; Prystay, M., National Research Council of Canada, Canada; Moreau, C., National Research Council of Canada, Canada; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

A series of thermal barrier coatings were deposited on superalloy pins by various techniques using different processing parameters, in order to optimize the durability of the coatings for aerospace applications. These coatings were subjected to simulated high temperature engine operating conditions in a high velocity burner rig. The durability of the coatings at different temperatures was assessed at regular intervals from changes in pin weight due to oxidation and/or loss of coating. The thermal characteristics of some of the coatings were also assessed on-line by monitoring the core temperatures of the pins. After thermal cycling, the specimens were subjected to metallographic examination, to study the change in microstructure brought about by the burner rig cyclic tests. The test methodology and the results are discussed.
Author
Thermal Control Coatings; Protective Coatings; Heat Resistant Alloys; Coating; Performance Tests; Durability

19980197446 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Materials Research, Cologne, Germany
GRADED DESIGN OF EB-PVD THERMAL BARRIER COATING SYSTEMS
Schulz, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Krell, T., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Leushake, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Peters, M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

The most durable TBCs (Thermal Barrier Coatings) are yttria partially stabilized zirconia coatings which are applied by EB-PVD (Electron Beam Physical Vapor Deposition) on metallic bond coats. The EB-PVD process offers the advantage of a superior strain and thermoshock tolerant behavior of the coatings due to their columnar microstructure. The interface between ceramic and metal is the weakest link in this system. Spallation occurs in that area which is mainly attributed to oxidation of the bondcoat and to thermomechanical stresses of this two-layered coating. The concept of graded materials is one approach to lower both stresses and also oxidation of the bondcoat. This concept is presented in detail with special emphasis on chemically graded alumina-zirconia TBCs. Microstructures and phases of alumina, alumina-zirconia, and of graded coatings deposited by EB-PVD are evaluated. Mainly alumina undergoes phase transformation in the mixed and graded layers from the amorphous state to the desired alpha-Al2O3. Finite element modeling was performed to study the influence of coating thickness and composition on heat flux and stress distribution.
Author
Thermal Control Coatings; Yttria-Stabilized Zirconia; Aluminum Oxides; Coating; Protective Coatings; Durability; Electron Beams; Vapor Deposition; Turbine Blades; Ceramics; Morphology; Finite Element Method

19980197447 NASA Lewis Research Center, Cleveland, OH United States
BOND COAT CONSIDERATIONS FOR THERMAL BARRIER COATINGS
Freborg, A. M., Deformation Control Technology, Inc., USA; Ferguson, B. L., Deformation Control Technology, Inc., USA; Brindley, W. J., NASA Lewis Research Center, USA; Petrus, G. J., Deformation Control Technology, Inc., USA; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

Bond coat oxidation has been clearly established as a factor contributing to the failure of a TBC. However, the mechanism by which oxidation effects TBC failure has not been determined. Similarly, other bond coat properties have been cited as influencing TBC residual stresses, but neither the magnitude of the effects nor the exact mechanisms by which these properties act, and interact, have been elucidated. A finite element model was developed to evaluate residual stresses induced by thermal cycling of a typical plasma sprayed TBC system. It was found that bond coat properties of oxidation, creep, coefficient of thermal expansion (CTE) and roughness, as well as top coat creep, all strongly influence ceramic layer stresses. Roughness and CTE were found to have the strong effects in a parametric study, acting primarily as stress multipliers for other active mechanisms. A detailed examination of the time dependent properties of creep and oxidation indicates that these factors account for evolution of the

residual stresses with thermal cycling. It is the combination of these effects over the lifetime of the coating that drives the generation of stresses required to initiate and propagate delamination cracks.
Author
Thermal Control Coatings; Oxidation; Protective Coatings; Ceramic Coatings; Finite Element Method; Mathematical Models; Residual Stress; Failure

19980197448 Wright Lab., Aero Propulsion and Power Directorate, Wright-Patterson AFB, OH United States
THE EFFECT OF TBC UTILIZATION IN THE DESIGN OF ROBUST AIRCRAFT COMBUSTORS
Arana, Carlos A., Wright Lab., USA; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

As performance objectives of new and derivative military engines require combustion systems to operate at higher pressures and temperatures, balancing conflicting demands of improved durability, stability, and operability becomes more difficult without technology improvements in combustor liner designs. Since combustor thermo-mechanical fatigue is currently a significant contributor to engine life cycle costs, improved structural durability must be achieved, without compromise of other combustor requirements. This paper addresses the application and verification of liner cooling schemes and their interaction with thermal barrier coatings (TBCs) for the design of robust aircraft turbine engine combustor liners to meet the above mentioned demands. An analytical investigation was conducted to determine the effect of TBCs on the average metal temperature for a full annular, semi-transpiration cooled combustor liner. The perspective is from a customer's viewpoint, a combustor liner designer who is continuously challenged to increase combustor temperature rise capability and operability for new products while maintaining cooling flow levels.
Author
Thermal Control Coatings; Aircraft Engines; Gas Turbine Engines; Combustion Chambers; Linings; Protective Coatings; Life (Durability); Thermal Fatigue; Heat Transfer; Ceramic Coatings

19980197449 Rolls-Royce Ltd., Derby, United Kingdom
ADVANTAGES/DISADVANTAGES OF VARIOUS TBC SYSTEMS AS PERCEIVED BY THE ENGINE MANUFACTURER
Morrell, P., Rolls-Royce Ltd., UK; Rickerby, D. S., Rolls-Royce Ltd., UK; Apr. 1998; 10p; In English; See also 19980197432; Copyright Waived; Avail: CASI; A02, Hardcopy; A10, Microfiche

This paper discusses the relative advantages and disadvantages of Thermal Barrier Coatings systems (TBC's) produced by thermal spraying and electron beam PVD processing technology from a design point of view. This paper reviews the structure/property relationships for electron-beam physical vapour deposition (EB-PVD) TBC's in contrast to those of plasma sprayed TBC's, particularly with respect to thermal conductivity, erosion resistance, and mechanical behaviour. Examples are used to show how, through the development of customized bond coat systems, the performance of TBC systems can be considerably enhanced, an important incremental step towards the ultimate goal of "designed-in TBC's".
Author
Thermal Control Coatings; Electron Beams; Vapor Deposition; Coating; Plasma Spraying; Protective Coatings; Gas Turbine Engines; Engine Parts; Performance Tests

19980204013 Purdue Univ., School of Aeronautics and Astronautics, West Lafayette, IN United States
APPLICATIONS OF TEMPERATURE AND PRESSURE SENSITIVE PAINTS
Liu, Tian-Shu, Purdue Univ., USA; Sullivan, John P., Purdue Univ., USA; May 1998; 10p; In English; See also 19980203985; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Luminescent molecular probes imbedded in a polymer binder form a temperature or pressure paint. On excitation by light of the proper wavelength, the luminescence, which is quenched either thermally or by oxygen, is detected by a camera or photodetector. From the detected luminescent intensity, temperature and pressure can be determined. The basic photophysics, calibration, accuracy and time response of a luminescent paint is described followed by applications in low speed, transonic, supersonic and cryogenic wind tunnels and in rotating machinery.
Author
Paints; Sensitivity; Pressure Measurement; Luminous Intensity; Luminescence

19980206023 Allison Engine Co., Rolls-Royce Aerospace Group, Indianapolis, IN United States
EFFECTIVE SPECTRAL EMISSIVITY MEASUREMENTS OF SUPERALLOYS AND YSZ THERMAL BARRIER COATING AT HIGH TEMPERATURE USING A 1.6 MICRON SINGLE WAVELENGTH PYROMETER
Alaruri, Sami, Allison Engine Co., USA; Bianchini, Lisa, Allison Engine Co., USA; Brewington, Andrew, Allison Engine Co., USA; May 1998; 12p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A method employing an integrating sphere and a single wavelength (1.6 micron) pyrometer for measuring the spectral effective emissivities of superalloys in the temperature range (approx. 650-1050 C) is described. The spectral effective emissivities for five superalloys, namely, MARM-247, MARM-509, CMSX-4, Inconel-7 18, N- 155, and two Rene-N6 samples coated with YSZ thermal barrier coating were measured. Correcting the pyrometer measurements for the variations in the object emissivity would reduce the uncertainty in the temperature measurements to less than +/- 1%.
Author
Temperature Measurement; Thermal Control Coatings; Yttria-Stabilized Zirconia; Heat Resistant Alloys; Pyrometers; Spectral Emission

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PROPELLANTS AND FUELS

19960008937 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
ENVIRONMENTAL ASPECTS OF ROCKET AND GUN PROPULSION *LES ASPECTS ENVIRONNEMENTAUX DA LA PROPULSION PAR FUSEE ET DES CANONS*
Feb 1, 1995; 351p; In English; In French; Propulsion and Energetics Panel (PEP) 84th Symposium, 29 Aug. - 2 Sep. 1994, Aalesund, Norway; See also 19960008938 through 19960008972
Report No.(s): AGARD-CP-559; Copyright Waived; Avail: CASI; A16, Hardcopy; A03, Microfiche; Original contains color illustrations

The Conference Proceedings contains papers presented at the Propulsion and Energetics Panel 84th Symposium on Environmental Aspects of Rocket and Gun Propulsion which was held on 29 Aug. -2 Sept 1994, in Aalesund, Norway. The Technical Evaluation Report and the Keynote Address are included at the beginning and discussions follow most papers. The Symposium was arranged in the following sessions: Clean Propellants (7); Propellant Development (6); Measurements (7); Disposal (3); Material Recovery and Re-Use (8); Contamination (5).
Conferences; Contamination; Environment Effects; Environment Protection; Gun Propellants; Materials Recovery; Propellant Tests; Rocket Exhaust; Solid Propellant Combustion; Solid Propellants; Solid Rocket Propellants

19960008940 Centre de Recherches du Bouchet, Vert de Petit, France
SOLID PROPELLANTS FOR SPACE LAUNCH VEHICLES NOT GENERATING OR LITTLE HYDROCHLORIC GAS *PROPERGOLS SOLIDES POUR LANCEURS SPATIAUX GENERANT PAS OU PEU DE GAZ CHLORHYDRIQUE*
Perut, C., Centre de Recherches du Bouchet, France; Bodart, V., Centre de Recherches du Bouchet, France; Cristofoli, B., Centre de Recherches du Bouchet, France; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 12 p; In French; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Solid propellants for space launch vehicles do not generate, or generate just a little of hydrochloric gas. The conventional propellants for accelerators of space launch vehicles contain as an oxidant ammonium perchlorate and generate, as a result, hydrochloric gas. Although

the effects on the environment are extremely weak, the studies are conducted to reduce this impact even further. The SNPE engaged the work along two axes, the propellants containing ammonium with high perchlorate rates and a chlorine sensor, and the formulations not containing a chlorinated species. This article describes the results obtained on the first type of composition. The propellants with chlorine sensor present a voluminal specific impulse of a level identical to that of the current compositions, but a weaker specific impulse, and good rheological, mechanical and ballistic properties. Experiments carried out on the effluents of engine of 1 kg or 40 kg made it possible to validate the concept and the choice of the formulations. The hydrochloric rate of acid, measured by an electrochemical method and infra-red spectrometry, is very strongly reduced, by approximately a factor 100. The rates of oxide of nitrogen, determined by chemiluminescence remain weak. The morphology and the grain size collected are given.
Author
Chlorine; Environment Effects; Grain Size; Hydrochloric Acid; Propellant Tests; Solid Propellants; Spacecraft Launching

19960008941 Phillips Lab., Propulsion Directorate., Edwards AFB, CA, United States
CLEAN PROPELLANTS FOR SPACE LAUNCH BOOSTERS
Beckman, Charles, Phillips Lab., USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 9 p; In French; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Phillips Laboratory Propulsion Directorate has been developing propulsion systems for space launch application which address environmental concerns (the clean propellant programs) since the late 1970's. The Applications Division (RKA) developed an environmental approach to eliminate hydrochloric acid as an exhaust product. This approach is in line with the Air Force space launch propulsion strategy. Application of environmentally acceptable propellant technology is evident in each step in the manufacturing process through conservation/disposal. Future propulsion systems will be required to comply with environmental regulations and laws. The Environmental Protection Agency has raised concern about acid rain and is calling for significant reduction of hydrochloric acid in the atmosphere. They have developed models to predict the environmental impact of hydrochloric acid from space launches in the atmosphere and its role in ozone depletion. The space launch strategy team stressed that these predictions of environmental impact need to be substantiated with hard data. It is essential that the space launch propulsion community develop alternative environmentally acceptable space launch propulsion systems. Development of space launch scavenger propellants has significantly reduced the amount of hydrochloric acid released into the atmosphere from greater than 20 percent to less than 2 percent. Solution propellant technology has potential as a chlorine-free propellant for space launch application. Advanced Environmental Propellant Development will evaluate high energy ingredients to replace current low density or low performance ingredients in propellant formulations to achieve equal or better performance than current solid systems. These steps are essential to ensure the future of space launches.
Author
Acid Rain; Environment Protection; Hydrochloric Acid; Ozone Depletion; Rocket Exhaust; Solid Rocket Propellants; Spacecraft Launching

19960008942 Norwegian Defence Research Establishment, Kjeller, Norway
IMPROVED ENVIRONMENTAL PROPERTIES OF A SOLID COMPOSITE PROPELLANT
Sollien, I., Norwegian Defence Research Establishment, Norway; Karsrud, T. K. Engen, Norwegian Defence Research Establishment, Norway; Johannessen, T. C., Norwegian Defence Research Establishment, Norway; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 8 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Due to environmental aspects of solid propulsion, the possibility to reduce or eliminate the concentration of HCl in rocket exhausts without compromising performance is of interest. This can be achieved in different ways. In an AP based propellant AP may be partially or fully replaced by another oxidizer. The influence on the amount of HCl in a rocket exhaust by partial replacement of AP with HMX in a specified AP/HTPB based propellant is presented together with effects on various other propellant properties. This include computer simulations and experiments on the energy content and the rocket exhaust signature as well as tests on mechanical and hazard properties of the propellant.
Author
Composite Propellants; Computerized Simulation; Environment Protection; HMX; Mechanical Properties; Propellant Properties; Propellant Tests; Propulsion System Performance; Rocket Exhaust; Thermodynamic Properties

19960008943 Fraunhofer-Inst. fuer Chemische Technologie, Pfinztal, Germany
DEVELOPMENT OF LESS POLLUTING PROPELLANTS
Menke, Klaus, Fraunhofer-Inst. fuer Chemische Technologie, Germany; BOEHNLEIN-MAUSS, Fraunhofer-Inst. fuer Chemische Technologie, Germany; Brehler, Klaus-Peter, Fraunhofer-Inst. fuer Chemische Technologie, Germany; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 13 p; In English; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Propellants based on ammonium nitrate and GAP are candidates not only for less polluting but high energetic, minimum smoke propellants with reduced sensitivity. They may act as suitable candidates for the substitution of double base propellants so far used in rocket motors for tactical defense. The difficulties for the development of such a propellant system depend on the chemical nature and problems connected to the ingredients. Drawbacks are caused by the numerous phase changes of AN, its hydroscopicity, lower energy and low reactivity. The key problems for the development are the unfavorable combustion behavior and sometimes bad stability of AN/GAP formulations. Some of the main features of these propellants have been developed and illustrated in this paper. These are performance, chemical stability combustion behavior and detonation sensitivity. Four different kinds of pure and phase stabilized ammonium nitrate are compared regarding stability and combustion behavior in propellant formulations with GAP and nitrate ester plasticizers. In consideration of stability, performance and detonation sensitivity the system of pure AN (SCAN), GAP, TMETN, BTTN without nitramines has been chosen for further development.
Author
Ammonium Nitrates; Combustion Efficiency; Environment Protection; Glycidyl Azide Polymer; Nitrate Esters; Plasticizers; Propellant Tests; Propulsion System Performance; Solid Propellant Combustion; Solid Rocket Propellants; Thermochemical Properties

19960008944 Naval Air Warfare Center, Weapons Div., China Lake, CA, United States
DEVELOPMENT OF ENVIRONMENTALLY ACCEPTABLE PROPELLANTS
Chan, May L., Naval Air Warfare Center, USA; Demay, Susan C., Naval Air Warfare Center, USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 5 p; In English; See also 19960008937; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

The propellant formulations at the Naval Air Warfare Center Weapons Division, China Lake, CA, following the guidelines of Insensitive Munitions and the global emphasis on a clean environment, have been developing environmentally responsible and insensitive propellant formulations for future weapon use. In this paper, a family of minimum-signature propellants composed of GAP and AN will be described. These propellants have shown excellent processing, mechanical, and combustion properties. In addition, they are considerably less sensitive to shock, heat, and mechanical impact than the conventional propellant material. This paper also summarizes the results of studies conducted on ADN to establish its properties when used in propellant applications. The research work primarily involved determining the safety characteristics of neat ADN and ADN propellant compositions, evaluating the thermocompatibility of ADN with a number of energetic binder ingredients, and examining the processing and aging properties of potential energetic binder/ADN propellants.
Author
Ammonium Compounds; Ammonium Nitrates; Combustion Efficiency; Environment Protection; Glycidyl Azide Polymer; Mechanical Properties; Propellant Binders; Propellant Tests; Solid Propellants

19960008946 Prins Maurits Lab. TNO, Rijswijk, Netherlands
HYDRAZINIUM NITROFORMATE AND ITS USE AS OXIDIZER IN HIGH PERFORMANCE SOLID PROPELLANTS
Gadiot, G. M. H. J. L., Prins Maurits Lab. TNO, Netherlands; Mul, J. M., Prins Maurits Lab. TNO, Netherlands; Vanlit, P. J., Aerospace Propulsion Products, Netherlands; Korting, P. A. O. G., Aerospace Propulsion Products, Netherlands; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 13 p; In English; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Hydrazinium nitroformate (HNF) is viewed as a promising new oxidizer. It has a high energy content and does not contain chlorine. When combined with an energetic binder like glycidyl azide polymer (GAP), high performance tactical propellants with low signatures are obtained. When adding aluminum fuel to the formulation, improved propellant performance is obtained for propellants suitable for space applications. In this paper, environmental, plume signature and theoretical performance aspects of HNF/GAP based solid propellants are considered, and the ballistic and material properties of HNF are summarized.
Author
Environment Protection; Glycidyl Azide Polymer; Hydrazinium Compounds; Nitroformates; Propellant Binders; Rocket Oxidizers; Solid Propellant Rocket Engines; Solid Propellants; Thermodynamic Properties

19960008947 Coimbra Univ., Lab. of Energetics and Detonics., Coimbra, Portugal
SHOCK SENSITIVITY OF AMMONIUM NITRATE BASED PROPELLANTS
Campos, J., Coimbra Univ., Portugal; Gois, J. C., Coimbra Univ., Portugal; Mendes, R., Coimbra Univ., Portugal; Cortez, P., Instituto Nacional de Engenhario e Technologia, Portugal; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 7 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Ammonium nitrate (AN) is the base component of a recent family of gas generators and rocket composite propellants with lower pollutants. They have the same polyurethane (PU) binder based in hydroxyl terminated polybutadiene (HTPB), a plasticizer (DOA) and a curing agent (IPDI), of the classic ammonium perchlorate (AP) based composite propellants. The impossibility of burn a pure AN-PU propellant at atmospheric pressure, with AN concentration standard of 80 weight percent, leads to find an inert additive component in order to increase insulation and decrease global initial density. The glass microballoons (GMB) have these properties. AN-PU-GMB composites varying the AN concentration from 80 to 90 percent, keeping constant the 4 percent of GMB, are our tested compositions. The existence of detonation regime in a propellant shows the security level at non-stationary regimes and at fragment impact initiation. An experimental technique to measure initiation of propellant, with a shock induced from a plastic explosive, is presented. A double resistive wire was placed coaxially inside acceptor, in order to allow the continuous measurement of detonation velocity and the position of extinction section, when it occurs. An aluminum crush bar, under detonation plate, shows clearly the extinction section zone. Experimental results show any initiation of detonation of mixtures AN-PU-GMB with concentration of AN lower than 83 percent. It is observed the initiation of AN-PU-GMB propellant with concentrations of AN of 83 percent, followed by extinction, near 110 mm, also verified by the observation of shocked propellant sample and crushed bar profiles. It was measured the initiation of AN-PU-GMB of concentrations of AN of 90 percent, followed by a non-stable detonation, with a detonation velocity of approx. 3200 m/s, and a periodicity of interruptions of period distance of approx. 5 mm. The obtained results prove the validity of tested procedures and show the possibility of using 4 percent of GMB as additives, in AN-PU base propellants with concentration of AN up to 83 percent.
Author
Ammonium Nitrates; Composite Propellants; Detonation; Gas Generators; HTPB Propellants; Microballoons; Propellant Additives; Propellant Binders; Propellant Tests; Rocket Propellants; Shock Tests; Velocity Measurement

19960008948 Academy of Sciences (Russia), Inst. of Chemical Physics., Chernogolovka, Russia
POSSIBLE WAYS OF DEVELOPMENT OF ECOLOGICALLY SAFE SOLID ROCKET PROPELLANTS
Manelis, G. B., Academy of Sciences (Russia), Russia; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 7 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The combustion products of conventional solid rocket propellants are known to comprise substantial quantities of pollutants, primarily hydrogen chlorides and other chlorine-containing compounds, carbon monoxide, and fine particulate alumina. Some propellants yield additionally to above-mentioned, highly toxic beryllium and fluorine compound. The concentration of the pollutants at the nozzle outlet can be essentially evaluated by thermodynamic calculation on the basis of the chemical composition of the propellant and conditions of stationary work of the engine. The evolution of the pollutants in the environment after they leave the nozzle is investigated but poorly. One can assume, however, that formation of the products of incomplete oxidation - dioxines and other carcinogenes, in particular - is highly likely, especially on the stages of ignition and extinguishing of the engine. The main source of the pollutants in the combustion products is the ammonium perchlorate (NH4CLO4), which is main oxidizer in conventional solid propellants.
Derived from text
Ammonium Nitrates; Chemical Composition; Combustion Chemistry; Combustion Products; Environment Protection; Hydrazinium Compounds; Nitroformates; Rocket Oxidizers; Solid Propellants; Solid Rocket Propellants

19960008949 Nobel's Explosives Co. Ltd., Stevenston, United Kingdom
DEVELOPMENT OF INSENSITIVE ROCKET PROPELLANTS BASED ON AMMONIUM NITRATE AND POLYNIMMO
Campbell, D., Nobel's Explosives Co. Ltd., UK; Cumming, A. S., Defence Research Agency, UK; Marshall, E. J., Nobel's Explosives Co. Ltd., UK; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 9 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Current composite propellant compositions for rocket motors make use of ammonium perchlorate (AP) and aluminium in a polyurethane binder based on a hydroxy terminated polybutadiene (HTPB). Increasing concern for the environment has resulted in a great deal of effort being devoted to finding replacements for AP which has a tendency to produce large amounts of HCl during combustion. Ammonium nitrate (AN) has been considered in the past as a replacement for AP but its use has been limited due both to a reduction in ballistic performance associated with its use, and to problems connected with phase changes in AN which can occur during the storage of AN or AN based propellants. Recent developments in the field of energetic binders have however resulted in the availability of several polymers such as polyNIMMO (PN), polyGLYN (PG), and glycidyl azide polymer (GAP), which when used in conjunction with AN, compensate for any reduction in performance caused by the replacement of AP. Similarly the use of phase stabilized grades of AN have minimized the problems associated with phase changes in AN on storage. The present paper details the work that was carried out at ICI Explosives in Scotland and the Defence Research Agency at Fort Halstead in England which led to the development of an insensitive low visible signature propellant formulation based on the use of ammonium nitrate with plasticized polyNIMMO as the binder. Theoretical calculations on a range of candidate compositions along with the ballistic, sensitiveness and rheological properties of the propellant formulation are described In addition various options for its further development are considered.
Author
Ammonium Nitrates; Ballistics; Composite Propellants; Environment Protection; Propellant Binders; Rocket Propellants; Solid Propellant Combustion; Solid Propellant Rocket Engines

19960008950 Naval Air Warfare Center, Weapons Div., China Lake, CA, United States
USE OF NEW OXIDIZERS AND BINDERS TO MEET CLEAN AIR REQUIREMENTS
Demay, S., Naval Air Warfare Center, USA; Braun, J. D., Naval Air Warfare Center, USA; AGARD, Environmental Aspects of Rocket and

Gun Propulsion; Feb 1, 1995, 4 p; In English; See also 19960008937; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

The burning of conventional solid rocket propellants introduces various substances into the atmosphere, including such noxious materials as hydrochloric acid and other reactive chlorine compounds, uncombusted fuel species, and toxic heavy metal oxides, as well as lighter metal oxides and alkali metal oxides. These materials can contaminate the natural landscape and water sources, degrade atmospheric quality, and even have the potential to affect atmospheric behavior (e.g., through ozone depletion). Advanced new energetic oxidizers and binders now being investigated, used in conjunction with selected conventional propellant ingredients, will allow the formulation of new propellants that will eliminate nearly all of these contaminants and still possess a high measure of performance. Oxidizers include an inorganic derivative of nitramidic acid and a dense 3-dimensional cyclic nitramine having high oxygen balances and favorable heats of formation. Binders include polyglycidyl and polyoxetane derivatives containing energetic azido or nitrato structures.

Author

Air Quality; Ammonium Compounds; Environment Protection; Nitramine Propellants; Plasticizers; Propellant Binders; Propulsion System Performance; Rocket Exhaust; Rocket Oxidizers; Solid Rocket Propellants

19960008951 Defence Research Establishment Valcartier, Courcellette Quebec, Canada

EVALUATION OF AMMONIUM NITRATE PROPELLANT EMISSIONS

Stowe, R. A., Defence Research Establishment Valcartier, Canada; Lessard, P., Defence Research Establishment Valcartier, Canada; Roy, G., Defence Research Establishment Valcartier, Canada; Richer, G., Defence Research Establishment Valcartier, Canada; Benchabane, M., Bristol Aerospace Ltd., Canada; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 12 p; In English; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Defense Research Establishment Valcartier has recently completed the exploratory development of a solid rocket propellant based on an ammonium nitrate (AN) oxidizer and a glycidyl azide polymer (GAP). Apart from developing a propellant with good energetic performance, improved safety and low observables, the goal was to obtain a propellant having an exhaust with few harmful emissions. This propellant has now been extensively tested, including the firings of several 70 mm diameter motors, four 200 mm diameter motors, small ballistic test motors inside a closed smoke chamber, and closed bomb tests. Estimates of the exhaust gas composition have been done using a thermochemical equilibrium computer code, and are supported by motor performance data and infrared emission spectra. The smoke chamber firings include mass extinction coefficient measurements of the exhaust smoke, derived from transmissometer data at the visible and 2-14 micron wavelengths. The closed bomb tests provided gas samples for Fourier transform infrared (FTIR) spectrometry and gas chromatography analysis of post-combustion exhaust products. Overall, the results indicated that the combustion of GAP/AN propellants produce exhaust emissions that are less harmful to the environment than those produced by ammonium perchlorate-based propellants. However, mainly because of the presence of zinc oxide in the AN, solid particulates in the exhaust form more primary smoke than a minimum smoke or reduced smoke propellant.

Author

Ammonium Nitrates; Combustion Products; Emission Spectra; Environment Protection; Exhaust Emission; Exhaust Gases; Gas Composition; Glycidyl Azide Polymer; Infrared Spectra; Propellant Combustion; Propellant Tests; Rocket Oxidizers; Solid Rocket Propellants

19960008953 Coimbra Univ., Lab. of Energetics and Detonics., Coimbra, Portugal

GAS POLLUTANTS FROM AMMONIUM NITRATE BASED PROPELLANTS

Campos, J., Coimbra Univ., Portugal; Araujo, L., Instituto Nacional de Engenhario e Technologia, Portugal; Gois, J., Coimbra Univ., Portugal; Pires, A., Coimbra Univ., Portugal; Mendes, R., Coimbra Univ., Portugal; Nina, M., Instituto Superior Tecnico, Portugal; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 7 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche; Original contains color illustrations

Ammonium nitrate (AN) is the base component of a low pollutant propellant, composed by polyurethane (PU) binder, based in hydroxyl terminated polybutadiene (HTPB), a plasticizer (DOA) and a curing agent (IPDI). The impossibility of burning a pure AN-PU propellant of AN concentration of 80 percent leads to find an additive component in order to increase thermal insulation and decrease the global initial density. Glass microballoons (GMB) have these properties and can be assumed as inert in combustion processes. AN-PU-GMB compositions, with AN concentrations from 80 to 90 percent, keeping constant 4 percent of GMB, were tested. Theoretical predictions of combustion pollutants were performed using THOR code, assuming thermodynamic equilibrium of combustion products for the minimum value of Gibbs free energy. Predictions shows negligible NO2 concentrations. CO emissions were more important than NO, in a good agreement with classic kinetic models. Experimental combustion samples were tested in a steel closed explosion chamber of 17 m(exp 3). They can be heated in the cases where it was not observed self sustained combustion. The real extinction of propellant of AN concentration of 80 percent, without GMB, was observed. A transition situation was verified in this composition with GMB. The combustion process of AN-PU-GMB, with AN concentrations of 83 percent, show heterogeneities, but seems to be relatively stable. Measured combustion temperatures for AN-PU-GMB with AN concentrations of 83 percent were near 1050 K. Measured values of combustion residues were always less than 3 percent of initial mass. The exhaust gas system is connected to a NO, CO, CO2, CH4 gas analyzers by IR spectroscopy. Measured concentrations of combustion products, corrected by the dilution factor, show very reliable results. For self sustained combustion, measured CO concentrations were higher than NO. In the other cases, NO concentrations being higher than CO, seems to indicate a pyrolysis regime. CO2 and NO were higher than the predicted values. The obtained results prove the validity of test procedures and show the existence of self sustained combustion, at atmospheric pressure, of AN-PU-GMB with AN concentrations of 83 percent.

Author

Ammonium Nitrates; Combustion Temperature; Environment Protection; Gibbs Free Energy; HTPB Propellants; Microballoons; Plasticizers; Propellant Binders; Propellant Tests; Rocket Exhaust; Solid Propellant Rocket Engines; Temperature Measurement; Thermodynamic Equilibrium

19960008954 Delegation Generale de l'Armement, Bourges, France

FORECAST OF THE IMPULSE NOISE OF THE ENGINES AT VERY SHORT TIME OF COMBUSTION *PREVISION DU BRUIT IMPULSIONNEL DES MOTEURS A TRES COURT TEMPS DE COMBUSTION*

Franco, P., Delegation Generale de l'Armement, France; Guernigou, J., Office National d'Etudes et de Recherches Aerospatiales, France; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 12 p; In French; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The shock wave and the high level acoustic waves emitted during the shooting of a missile or a rocket driven by an engine at very short time of combustion (10 ms) can involve a risk of damage to hearing. For these reasons, a number of tools were adapted, usable at the stages of design or evaluation of the project. Thus, in the case of the shootings in free field, an semi-empirical model was developed. This model is based on a model of total explosion to address the generation and the propagation of shock waves generated by an isotropic and instantaneous release of energy. It was then adapted to the case of the engines, starting from results representing a systematic variation of the parameters of design. Lastly, for the shootings simulating the combat in urban area, an experimental study made it possible to specify the mechanisms of formation and reflection of the shock waves on the walls. In addition, a number of tests, according to an experi-

mental design utilizing various characteristics of engines and organization of closed space, made it possible to develop estimated rules and abaci.
Author
Engine Tests; Experiment Design; Mathematical Models; Noise Prediction; Rocket Engine Noise; Rocket Engines; Shock Wave Propagation; Shock Waves; Sound Waves

19960008959 Rockwell International Corp., Rocketdyne Div., Canoga Park, CA, United States
DESTRUCTION OF PROPELLANT WASTES USING MOLTEN SALT OXIDATION
Flanagan, J. E., Rockwell International Corp., USA; Stewart, A. E., Rockwell International Corp., USA; Weber, J. F., Rockwell International Corp., USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 4 p; In English; See also 19960008937; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Molten Salt Oxidation (MSO) is a safe and environmentally acceptable technology for the disposal of energetic waste materials. Initial experiments carried out more than 20 years ago have been supplemented recently with additional work and process improvements. Destruction of energetic materials is nearly quantitative under the current design conditions. The applicability to specialized ordnance wastes is currently under study. These wastes contain a series of chemical elements that are inappropriate to feed to more conventional destruction devices such as incinerators.
Author
Molten Salts; Oxidation; Rocket Propellants; Waste Disposal

19960008960 Aerojet-General Corp., Rancho Cordova, CA, United States
A COMPLETE RESOURCE RECOVERY SYSTEM FOR SOLID ROCKET PROPELLANTS
Biagioni, Joseph R., Jr., Aerojet-General Corp., USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 6 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Open burn and open detonation (OB/OD) are currently the methods of choice for disposal of Class 1.1 and Class 1.3 explosive materials. OB/OD methods dispose of the combustion by-products through dispersal into the air and the burial of any residual ash with no recovery of materials other than possibly scrap metal. This paper describes a system which controls emissions to regulatory requirements or below, recovers materials for reuse or recycling, and is designed to be an environmentally acceptable alternative to OB/OD. This three step process removes the energetic material from its container using high pressure water; desensitizes the removed material, making it suitable for thermal treatment; and then disposes of the remaining material in a specially designed incineration system. Test operations completed to date using Class 1.3 solid rocket propellant have demonstrated that this process can recover approximately 90 percent of the starting mass, providing revenue to offset the cost of operation. Recovered materials were ammonium perchlorate (70 percent) and aluminum oxide (20 percent) in these tests. The waste stream is the 25 percent salt solution from the caustic scrubbers which amounts to approximately one gallon (3.8 cu dm) per 250 pounds (113 kg) of material thermally treated. All tests have been conducted under the auspices of research, development and demonstration permits granted by federal, state, and local agencies. System development has proceeded along a logical course consisting of equipment development, worst case testing, and optimization. A fully permitted facility is planned to be operational in 1995.
Author
Aluminum Oxides; Ammonium Perchlorates; Environment Protection; Materials Recovery; Performance Tests; Solid Rocket Propellants; Toxic Hazards

19960008961 Phillips Lab., Edwards AFB, CA, United States
RECLAIMED AND VIRGIN AMMONIUM PERCHLORATE VARIATIONS AND HOW THEY AFFECT SOLID PROPELLANT PROPERTIES
Durham, S. E., Phillips Lab., USA; Schwartz, D. F., Phillips Lab., USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 17 p; In English; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Ammonium perchlorate (AP) reclaimed using the water dissolving technique developed by Thiokol Corporation was compared with the two U.S. manufactured AP's in a polybutadiene-acrylic acidacrylonitrile terpolymer (PBAN) propellant formulation. The reclaimed AP was directly substituted for the virgin materials and natural variances for the propellant mixes were established in the areas of processing, mechanics, and ballistics. The PBAN propellant formulations were scaled up to the 30-gallon mix size and 70-pound Ballistic Test & Evaluation System (BATES) Motors were cast and fired. In addition an 800-pound Super BATES motor was fired. Analyses of the reclaimed and virgin AP samples were performed to identify the chemical properties' variabilities. Results proved that reclaimed AP has the potential to be reused in the solid-rocket-motor industry.
Author
Ammonium Perchlorates; Ballistics; Chemical Analysis; Environment Protection; Materials Recovery; Mechanical Properties; Propellant Properties; Solid Propellants

19960008962 Societe Nationale des Poudres et Explosifs, Defense Espace Div., Saint-Medard-en-Jalles, France
DESTRUCTION OF SOLID PROPELLANT ROCKET MOTORS WITH RECUPERATION OF ENERGETIC MATERIALS *DESTRUCTION DES MOTEURS FUSEE A PROPERGOL SOLIDE AVEC RECUPERATION DES MATIERES ENERGETIQUES A HAUTE VALEUR AJOUTEE*
Gaudre, Marie, Societe Nationale des Poudres et Explosifs, France; Tauzia, Jean Michel, Societe Nationale des Poudres et Explosifs, France; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 6 p; In French; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The process of destruction of solid propellant rocket engines that minimizes the rejections in water and atmosphere and provides the materials' recovery is presented. Cost effectiveness is still a problem to be resolved.
Derived from text
Ammonium Perchlorates; Environment Protection; Materials Recovery; Solid Propellant Rocket Engines; Solid Rocket Propellants

19960008963 Hercules Aerospace Co., Magna, UT, United States
CRITICAL FLUID DEMILITARIZATION AND INGREDIENT RECLAMATION TECHNOLOGY
Morgan, Mark E., Hercules Aerospace Co., USA; Mitchell, Donald H., Hercules Aerospace Co., USA; Stevens, Phil M., Hercules Aerospace Co., USA; Melvin, William S., Army Missile Command, USA; Schirk, Peter G., Rust International, USA; Manar, Otis J., Rust International, USA; Rizzardi, Ned W., Army Corps., USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 11 p; In English; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Department of Defense has a tactical requirement to develop alternative technologies to dispose of large numbers of solid rocket motors without harming the environment. Research efforts conducted at the bench-scale have successfully demonstrated the advantages of the U.S. Army Missile Command (MICOM) critical fluid technology for safe and efficient demilitarization of solid rocket motors. This method has been successfully used to recover valuable ingradients, such as cyclotetramethylenetetranitramine (HMX), cyclotrimethylenetrinitramine (RDX), ammonium perchlorate (AP), and aluminum (AL)/binder, from tactical and strategic Class 1.1 and 1.3 solid propellants. The process uses liquid ammonia for ingredient extraction and recovery. Under an Army-sponsored effort, Hercules Aerospace Company and Rust International have been awarded a contract to design and build a pilot plant test facility, and to demonstrate this demilitarization process on Class 1.1 and Class 1.3 solid rocket motors.
Derived from text
Ammonium Perchlorates; Disposal; Environment Protection; HMX; Liquid Ammonia; Materials Recovery; Propellant Binders; RDX; Solid Propellant Rocket Engines; Solid Propellants

19960008964 Imperial Chemical Industries Ltd., Stevenston, United Kingdom
RECYCLING MILITARY ENERGETIC MATERIALS INTO PRODUCTS FOR COMMERICAL EXPLOSIVE APPLICATIONS
Brown, D. W., Imperial Chemical Industries Ltd., UK; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 5 p;

In English; See also 19960008937; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Technical trends in the design of explosives for mining, quarrying and construction have for the last twenty-five years been towards a reduction in the presence of chemical sensitizers. Most recent formulations for blasting have eliminated chemical or high explosive sensitizers altogether. These developments brought benefits of lower E material costs and increased safety in manufacture and use. With the availability of huge quantities of military explosives and propellants from cold war stockpiles now a reality, the industry has to consider what commercial and technical impact these military surplusses will have on existing and new markets, and on the products which are offered for a wide range of field applications . The paper discusses features of available surplus energetic materials which must be considered when designing into civil explosives products and the product characteristics necessary for successful field application. The processes chosen to determine the safety of manufacturing and use are explained and ICI experience in supplying to the market is described.

Author

Environment Protection; Explosives; Materials Recovery; Recycling; Rocket Propellants

19960008966 NASA Marshall Space Flight Center, Huntsville, AL, United States

REDUCED HAZARD CHEMICALS FOR SOLID ROCKET MOTOR PRODUCTION

Caddy, Larry A., NASA Marshall Space Flight Center, USA; Bowman, Ross, Thiokol Corp., USA; Richards, Rex A., Thiokol Corp., USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 11 p; In English; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche; Original contains color illustrations

During the last three years. the NASA/Thiokol/industry team has developed and started implementation of an environmentally sound manufacturing plan for the continued production of solid rocket motors. NASA Marshall Space Flight Center (MSFC) and Thiokol Corporation have worked with other industry representatives and the U.S. Environmental Protection Agency (EPA) to prepare a comprehensive plan to eliminate all ozone depleting chemicals from manufacturing processes and reduce the use of other hazardous materials used to produce the space shuttle reusable solid rocket motors. The team used a classical approach for problem-solving combined with a creative synthesis of new approaches to attack this challenge.

Author

Environment Protection; Manufacturing; Reusable Rocket Engines; Solid Propellant Rocket Engines; Toxic Hazards

19960008967 NASA Marshall Space Flight Center, Huntsville, AL, United States

PRIORITIZATION METHODOLOGY FOR CHEMICAL REPLACEMENT

Goldberg, Ben, NASA Marshall Space Flight Center, USA; Cruit, Wendy, NASA Marshall Space Flight Center, USA; Schutzenhofer, Scott, NASA Marshall Space Flight Center, USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 12 p; In English; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This methodology serves to define a system for effective prioritization of efforts required to develop replacement technologies mandated by imposed and forecast legislation. The methodology used is a semi quantitative approach derived from quality function deployment techniques (QFD Matrix). QFD is a conceptual map that provides a method of transforming customer wants and needs into quantitative engineering terms. This methodology aims to weight the full environmental, cost, safety, reliability, and programmatic implications of replacement technology development to allow appropriate identification of viable candidates and programmatic alternatives.

Author

Chemicals; Environment Pollution; Environment Protection; Process Control (Industry); Replacing

19960008969 Defence Research Establishment Valcartier, Dept. of National Defence., Courcellette Quebec, Canada

BIODEGRADATION OF ENERGETIC COMPOUNDS: APPLICATION TO SITE RESTORATION

Thiboutot, S., Defence Research Establishment Valcartier, Canada; Lavigne, J., Defence Research Establishment Valcartier, Canada; Ampleman, G., Defence Research Establishment Valcartier, Canada; Richer, G., Defence Research Establishment Valcartier, Canada; Lavertu, R., Defence Research Establishment Valcartier, Canada; Hawari, J., National Research Council of Canada, Canada; Greer, C., National Research Council of Canada, Canada; Rho, D., National Research Council of Canada, Canada; Jones, A., National Research Council of Canada, Canada; Renoux, A., National Research Council of Canada, Canada; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 6 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A multidisciplinary approach involving chemistry, microbiology, ecotoxicology and bioengineering has been undertaken in a joint effort involving the Defence Research Establishment, Valcartier of National Defence Canada (DREV/DND) and the Biotechnology Research Institute of the National Research Council of Canada (BRI/NRC). The aim of this joint collaboration is to study the bioremediation of soils contaminated with energetic compounds such as RDX, TNT, NC and GAP. Contaminated sites were sampled and analyzed for the presence of TNT, RDX and NC. Modified EPA SW 846 Method 8330 was used for the determination of RDX and TNT. As expected, the method was found accurate (greater than or equal to 90 percent recovery), precise (relative deviation standard less than or equal to 2 percent) and sensitive (detection limit less than or equal to 0.5 mg/Kg) over a range of concentration from 0.5 to 20,000 mg/Kg of soil dry weight. Labeled - C-14 energetic compounds were synthesized to monitor their biodegradation. Contaminated soils were screened for microorganisms having the ability to mineralize energetic compounds. Bacteria were isolated from RDX contaminated soils based on their ability to use RDX as the sole source of nitrogen under aerobic conditions when amended with a carbon source. Using C-14 labeled RDX, the ability of these isolates to mineralize RDX in liquid medium was verified. Laboratory-scale studies using the isolates to bioremediate RDX contaminated soils indicate that bioaugmentation enhances the rate and extent of RDX biodegradation. TNT contaminated soils exhibited concentration dependent C-14-TNT mineralization activity. GAP is a relatively new energetic compound and might not yet be found as a soil contaminant. However, a soil sampled on a burning range showed some C-14-GAP mineralization activity. NC mineralization studies are planned in the near future.

Author

Bacteria; Biodegradation; Carbon 14; Cellulose Nitrate; Contamination; Glycidyl Azide Polymer; Microorganisms; RDX; SOils; Trinitrotoluene

19960008970 Aerojet-General Corp., Propulsion Systems Plant., Sacramento, CA, United States

EVALUATION OF ENVIRONMENTALLY ACCEPTABLE CLEANERS AS REPLACEMENTS FOR METHYL ETHYL KETONE AND 1,1,1 TRICHLOROETHANE IN SOLID ROCKET MOTOR PRODUCTION AND MAINTENANCE APPLICATIONS

Harrison, A. C., Aerojet-General Corp., USA; Marlow, M. E., Aerojet-General Corp., USA; Levi, L. D., Aerojet-General Corp., USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 6 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The use of 1,1,1 trichloroethane (TCA) will be restricted and ultimately prohibited under the U.S. Clean Air Act and the Montreal Protocol. Use of methyl ethyl ketone (MEK) is currently being restricted by various state air quality districts in California and across the USA. Used widely in the production of composite, metallic, and polymeric components as cleaning solvents, TCA and MEK have long been accepted as diverse and effective solvents by many manufacturers. Therefore, evaluation of potential TCA and MEK replacements requires numerous application considerations, ranging from simple

hardware and tooling cleanup to pre-bond cleaning preparation of critical bonds. This test program evaluates a wide variety of potential solvent replacements within this wide range of common applications.
Author
Chemical Cleaning; Cleaners; Composite Materials; Data Reduction; Environment Protection; Performance Tests; Solid Propellant Rocket Engines; Solvents

19960008971 Aerojet-General Corp., Propulsion Systems Plant., Sacramento, CA, United States
FINDING AN ENVIRONMENTALLY ACCEPTABLE REPLACEMENT FOR FREON 114B2 (HALON 2402) THAT MEETS MINUTEMAN LITVC PERFORMANCE CRITERIA
Shell, Vaughn, Aerojet-General Corp., USA; Harrison, Anthony, Aerojet-General Corp., USA; Nimitz, Jon, Environmental Technology and Education Consultants, USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 8 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Freon 114B2 (Halon 2402) is injected into the hot gas exhaust stream of the Minuteman Second Stage solid propellant rocket motor nozzle to provide thrust vector control. In response to environmental concerns, specifically ozone depletion, the USA Air Force has established a program to find and qualify a replacement for Freon 114B2. This program is currently approaching three years of age. Phase 1 of the program consisting of studies and analyses to identify the most promising candidates followed by laboratory testing and full scale motor tests to further screen the candidates down to a single selection (perfluorohexane) has been successfully completed. Phase 2 of the program consisting of qualification firings is scheduled for the latter part of this year and next year.
Author
Data Reduction; Environment Protection; Freon; Full Scale Tests; Gas Injection; Minuteman Icbm; Ozone Depletion; Perfluoro Compounds; Replacing; Solid Propellant Rocket Engines

19960008972 Deutsche Aerospace A.G., Moeckmuehl, Germany
PROPELLANT HANDLING PROVISIONS AT A TEST FACILITY FOR HYPERGOLIC BIPROPELLANT ROCKET ENGINES
Schulte, G., Deutsche Aerospace A.G., Germany; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 6 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Ground testing of bipropellant rocket engines with storable propellants demands for adequate test facility concepts to fulfill the needs with respect lo health hazards and safety aspects. The general properties and handling instructions for the latest most important hypergolic propellants are reviewed. For a 20 - 30 kN engine to be tested at sea level conditions with the hypergolic propellant, type Monomethyl Hydrazine (MMH) and Nitrogen Tetroxid (N2O4), test facility lay-out criteria are presented for two test positions. Design concepts and test facility handling during propellant loading/deloading and hot run phase are described for an engine.
Author
Ground Tests; Hypergolic Rocket Propellants; Materials Handling; Rocket Engines; Storable Propellants; Test Facilities

19970011969 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
IMPACT STUDY ON THE USE OF JET A FUEL IN MILITARY AIRCRAFT DURING OPERATIONS IN EUROPE *ETUDE DE L'IMPACT DE L'UTILISATION DU CARBURANT JET A PAR LES AVIONS MILITARES LORS DES OPERATIONS EN EUROPE*
Batchelor, Graham, Advisory Group for Aerospace Research and Development, France; Moses, Cliff, Advisory Group for Aerospace Research and Development, France; Fletcher, Ron, Advisory Group for Aerospace Research and Development, France; Jan. 1997; 16p; In English
Report No.(s): AGARD-R-801; ISBN 92-836-1049-0; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

The differences in specifications and actual supply properties of kerosene fuels JET A1 and JET A are studied. Potential operation limitations within the European military arena are outlined in the case that JET A was to replace JET A1 as the base fuel in the NATO F-34 fuel specification. Interviews with the military users and the suppliers of the equipment and fuels are reported on.
Author
Jet Engine Fuels; Kerosene; Specifications; Attack Aircraft

19970034746 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
SERVICE LIFE OF SOLID PROPELLANT SYSTEMS *LA DUREE DE VIE DES SYSTEMES A ERGOLS SOLIDES*
May 1997; 494p; In English; In French; 87th, 10-14 May 1996, Athens, Greece; See also 19970034747 through 19970034788; Original contains color illustrations
Report No.(s): AGARD-CP-586; ISBN 92-836-0036-3; Copyright Waived; Avail: CASI; A21, Hardcopy; A04, Microfiche

The Propulsion and Energetics Panel Symposium on Service Life of Solid Propellant Motors was held from 10-14 May 1996, in Athens, Greece. It dealt with the methods of extending and predicting service life of solid propellant systems for rockets, gas generators and guns. It also dealt with shelf life under varying conditions. This defence-specific symposium was aimed at improving system reliability, safety and cost. There were five sessions (43 papers) and a keynote address: Chemical and Physical Aging Mechanisms; Non-Destructive Test Methods; Gun Propellants; Methodologies and Techniques for Determining Service Life; Application of the Service Life Methodology and Techniques to Rocket Motor Systems.
Author
Service Life; Solid Propellant Rocket Engines; Gun Propellants; Storage Stability; Reliability; Aging (Materials); Predictions; Solid Propellants; Nondestructive Tests

19970034747 Naval Air Warfare Center, Weapons Div., China Lake, CA United States
DEVELOPMENT OF METHODS FOR AGING AND ANALYZING PROPELLANTS CONTAINING NITRATE ESTER STABILIZED WITH MNA AND 2-NDPA
Carpenter, P. S., Naval Air Warfare Center, USA; Atwood, A., Naval Air Warfare Center, USA; Meade, C. J., Naval Air Warfare Center, USA; Carey, N., Naval Air Warfare Center, USA; Paiz, A., Naval Air Warfare Center, USA; May 1997; 6p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The objective of this work was to develop a reliable and safe method, for the accelerated aging, of propellants at different known relative humidities. Safety testing, nitrate ester content, and stabilizer levels were monitored. The safety testing was completed to ensure that all of the samples were safe to handle and store and to determine if aging had any effect on the propellants sensitivity to impact, friction and electrostatic discharge.
Author
Aging (Materials); Propellants; Humidity; Safety; Nitrate Esters; Stability; Accelerated Life Tests

19970034748 Fraunhofer-Inst. fuer Chemische Technologie, Pfinztal, Germany
METHODS AND KINETIC MODELS FOR THE LIFETIME ASSESSMENT OF SOLID PROPELLANTS
Bohn, Manfred A., Fraunhofer-Inst. fuer Chemische Technologie, Germany; May 1997; 10p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The relatively low bond energy of the energetic groups of explosives, typical values are between 150 kJ/mol and 250 kJ/mol, together with frequently occurring low values of the activation energies, between 90 kJ/mol and 200 kJ/mol, lead to an increase in the rate of aging in the case of energetic substances when compared to chemical substances such as toluene and heptane, which are more stable. The activation energies for physical and physical-chemical aging can be even lower, typical values for the migration of plasticizers, phlegmatizers (deterrents), and burning catalysts are about 50 kJ/mol to 100 kJ/mol. The aging of gun propellants (GPs) and solid rocket propellants (RPs) expresses itself in many quantities and properties: in chemical properties such as mean molar masses of polymers, degree of cross-linking, content of stabilizers, antioxidants and plasticizers, in mechanical properties such as tensile strength, strain at break, compressive strength, elasticity and shear modulus, glass transition temperature and embrittlement temperature, in "composite values" such as specific impulse, burning rate, ignition delay, vivacity and

muzzle velocity. As aging can only be slowed down by means of stabilizers and not really stopped, the specified properties of GPs and RPs are altered with time-temperature stresses. This makes the substances dangerous whilst in storage and when in use. The hazards are known as spontaneous ignition, breech blow and motor explosion But also the designed performance data of a gun or a rocket are changed, which expresses itself in a lowering of the muzzle velocity, bad target picture and in the case of RP in a non-controlled burning rate. Therefore it is necessary to quantify aging processes in order to be able to specify after what time-temperature stresses the properties required still lie within the range of tolerance that means to make a reliable prediction The quantification is done using mathematical descriptions of the changes in the values of properties, which are connected to the relevant aging processes, as a function of time and temperature. If necessary also further variables such as humidity and oxygen are included. The description must achieve a separation between time and temperature so that a prediction for other time-temperature values becomes possible. This procedure will be described using a number of examples: migration of burning catalysts, decrease in the mean molar masses Mn, Mw and Mz of nitrocellulose in the propellants, stabilizer consumption, decrease of mechanical properties, mass loss, and heat generation, the latter two also with autocatalysis.
Author
Explosives; Activation Energy; Aging (Materials); Solid Propellants; Solid Rocket Propellants; Tensile Strength; Mechanical Properties; Toluene; Compressive Strength; Shear Properties; Embrittlement; Specific Impulse; Burning Rate; Modulus of Elasticity; Gun Propellants

19970034749 Centre de Recherches du Bouchet, Div. Propulsion, Vert de Petit, France
CHARACTERISTICS AND DETERMINATION OF THE AGING OF SOLID PROPELLANTS *CARACTERISATION ET MODELISATION DU VIEILLISSEMENT DES PROPERGOLS SOLIDES*
Perut, C., Societe Nationale des Poudres et Explosifs, France; Chevalier, S., Societe Nationale des Poudres et Explosifs, France; Minguet, L., Societe Nationale des Poudres et Explosifs, France; Service Life of Solid Propellant Systems; May 1997; 10p; In French; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The aging study methodology is joined to the propellant formulation researches from the aging behavior optimization at laboratory scale to the characterization. The characterizations are realized on case-bonded mock-ups which are subjected to thermal cycles designed to accelerate the aging produced by environment encountered in airborne applications. 2 months cycle is expected to simulate 1 year of service life. The mock-ups are dissected after 1 or 2 years. The testing are mainly directed at looking at changes in propellant and bonding mechanical properties. The results may be used to assess the service life of a rocket motor loaded with the propellant tested. The experimentations conducted during 1 year on a reduced-smoke propellant containing Butacene(registered trademark) as bum rate catalyst show the good aging behavior of this composition.
Author
Aging (Materials); Propellant Properties; Characterization; Optimization; Case Bonded Propellants; Solid Propellants; Airborne Equipment

19970034750 Naval Air Warfare Center, Weapons Div., China Lake, CA United States
HAZARD TESTING OF FERROCENE PROPELLANT IN THE SRAM-A MOTOR
Swett, Mark, Naval Air Warfare Center, USA; May 1997; 8p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In June of 1990, the USA Secretary of Defense banned Short Range Attack Missile-A (SRAM-A) from being loaded aboard the B-52, B-1, and F111 bombers. He was concerned that the ferrocene-containing rocket motors could inadvertently detonate and spread plutonium dust over large areas. Tests were conducted to ascertain that the motors were safe enough to be shipped to a facility where they could be properly disposed. The data and methods used to handle the propellant are described herein and may be of interest to anyone contemplating the handling, storing, or formulating of ferrocene-based propellants.
Author
Bomber Aircraft; B-1 Aircraft; B-52 Aircraft; F-111 Aircraft; Ferrocenes; Rocket Engines; Hazards

19970034751 Laboratorio Quimico Central de Armamento, Dept. of Ballistic, Madrid, Spain
AGEING BEHAVIOUR OF COMPOSITE PROPELLANTS
Jenaro, G., Laboratorio Quimico Central de Armamento, Spain; Rey, F., Laboratorio Quimico Central de Armamento, Spain; delaCruz, E., Laboratorio Quimico Central de Armamento, Spain; Perez, V., Laboratorio Quimico Central de Armamento, Spain; May 1997; 10p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A study has been conducted to know the effect of aging over mechanical and ballistic properties of composite propellants. Natural aging tests and accelerated aging tests at elevated temperatures have been performed for five different formulations of rocket propellants; the aging process has an effect on mechanical, chemical and ballistic properties. Measurements of tensile, viscoelastic and ballistic properties are reported. A relationship between shore A hardness and tensile properties has been established. Application of a theoretical prediction model has permitted conclusions to be drawn about service life, effect of environmental conditions and propellant mechanical requirements.
Author
Aging (Materials); Accelerated Life Tests; Ballistics; Mechanical Properties; High Temperature; Rocket Propellants; Chemical Properties; Composite Propellants

19970034752 Phillips Lab., Edwards AFB, CA United States
MICROSTRUCTURAL DAMAGE AND CRACK GROWTH BEHAVIOR IN A COMPOSITE SOLID PROPELLANT
Liu, C. T., Phillips Lab., USA; May 1997; 10p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The effects of temperature and crosshead speed on the local damage near the crack tip and the crack growth behavior in a composite solid propellant were investigated. In this study, three temperatures (165 F, 72 F and -65 F) and two crosshead speeds (2.54 mm/min and 12.7 mm/min) were considered. The experimental data were analyzed and the results are discussed.
Author
Temperature Effects; Solid Propellants; Microstructure; Crack Propagation; Damage; Crack Tips; Composite Propellants

19970034753 Defence Research Agency, Fort Halstead, United Kingdom
AGEING AND LIFE PREDICTION OF COMPOSITE PROPELLANT MOTORS
Cunliffe, A. V., Defence Research Agency, UK; Davis, A., Defence Research Agency, UK; Tod, D., Defence Research Agency, UK; May 1997; 8p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The factors which need to be considered in the aging, life prediction and life extension of composite propellant motors are considered. The chemical and physical changes which can occur are described, with particular reference to compositions based on hydroxy-terminated polybutadiene binders. The importance of atmospheric oxygen in the process is emphasized, and the factors determining the rate of the critical aging processes are discussed. Accelerated aging experiments are described, and the information necessary for extrapolation of such data to service temperatures is considered. In order to discuss service lifetimes, it is necessary to have reliable data describing the service environment. The effect of environment, such as temperature, on propellant aging is considered. The importance of motor design, and its tolerance to changes due to aging, is discussed, and simple measures which can be taken to extend motor service life are described.
Author
Aging (Materials); Accelerated Life Tests; Composite Propellants; Binders (Materials); Oxygen; Polybutadiene; Life (Durability)

19970034754 Fraunhofer-Inst. fuer Chemische Technologie, Pfinztal, Germany
LIFE TIME ASSESSMENT AND STABILITY OF AN/GAP PROPELLANTS
Bohn, Manfred A., Fraunhofer-Inst. fuer Chemische Technologie, Germany; Boehnlein-Mauss, Jutta, Fraunhofer-Inst. fuer Chemische Technologie, Germany; Menke, Klaus, Fraunhofer-Inst. fuer Chemische Technologie, Germany; May 1997; 16p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

If the ingredients and their chemical properties are considered, propellants based on ammonium nitrate, GAP binder and nitrate ester plasticizers are a challenge to achieve good chemical stability and a sufficient life time. This contribution gives a short overview about the chemical stability of propellant formulations with pure AN (so-called SCAN with less than 0.04 mass% water content) and phase stabilized AN (PSAN) in AN/GAP/TMETN/BTTN-based formulations and with a new burn rate modifier based on mixed molybdenum/vanadium oxides called MOVO. Stabilizer consumption, mass loss, cube crack thermal cycling and other aging tests were performed with distinctive formulations. It is shown that phase stabilizing metal complexes for AN as well as BTTN deteriorate the chemical stability and shorten the life time of the propellants. DPA and a mixture of MNA/2NDPA prove to be suitable stabilizers. Stabilizer consumption is described with an improved kinetic formulation based on a combination of the reactions of first and zero order. For the prediction of life times with mass loss as function of time and temperature an autocatalytic rate equation is used. As a result of the development a propellant formulation was found with medium performance (I(SP) = 229 s at 7 MPa) based on pure AN in AN/GAP/ TMETN with MOVO burn rate modifier, which has satisfying values for chemical stability and a sufficient life time. The propellant will meet the applicational profiles of a temperate climate.
Author
Chemical Properties; Ammonium Nitrates; Glycidyl Azide Polymer; Nitrate Esters; Plasticizers; Chemical Reactions; Burning Rate; Molybdenum Oxides; Vanadium Oxides; Binders (Materials)

19970034755 Defence Research Establishment Valcartier, Weapon System Div., Courcellette, Quebec Canada
CHARACTERIZATION OF THE DEGRADATION OF THE POLYMER BINDER IN GAP-BASED PROPELLANTS
Desilets, S., Defence Research Establishment Valcartier, Canada; Perreault, F., Defence Research Establishment Valcartier, Canada; May 1997; 6p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Reliability assessment for composite propellants call for effective shelf-life predicting tools, implying the existence of appropriate accelerated aging procedures and of quantitative methods for the characterization of the degradation process. Ideally. one would like to investigate stabilizer depletion as well as the mechanical integrity of the polymeric network used as the binder. There are many available methods that can be combined to achieve this goal. In the present work, a comparative study of two of these methods has been performed. The first procedure makes use of FTIR spectroscopy to characterize the binder's degradation and of HPLC to follow stabilizer depletion. The other method based on H-1 NMR spectroscopy allows the measurement of the polymer network degradation, the depletion of the stabilizer and the loss of plasticizer in a single step. Finally, the pros and cons of both procedures have been evaluated from the analysis of experimental data related to the accelerated aging at 40, 60 and 80 C of GAP-based composite propellant formulations.
Derived from text
Binders (Materials); Degradation; Aging (Materials); Accelerated Life Tests; Glycidyl Azide Polymer; Infrared Spectroscopy; Storage Stability; Composite Propellants

19970034756 Office National d'Etudes et de Recherches Aerospatiales, Toulouse, France
APPLICATION OF SEVERAL GLOBAL METHODS FOR NON DESTRUCTIVE EVALUATION OF SMALL SOLID PROPELLANT MOTORS *APPLICABILITE DE QUELQUES METHODES GLOBALES AU CND DES PETITS PROPULSEURS A PROPERGOL SOLIDE*
Deom, A., Office National d'Etudes et de Recherches Aerospatiales, France; Lepoutre, F., Office National d'Etudes et de Recherches Aerospatiales, France; Krapez, J. C., Office National d'Etudes et de Recherches Aerospatiales, France; Mason, C., Office National d'Etudes et de Recherches Aerospatiales, France; Christophe, F., Centre d'Etudes et de Recherches, France; Balageas, D. L., Office National d'Etudes et de Recherches Aerospatiales, France; May 1997; 14p; In French; See also 19970034746; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

After manufacturing, missiles may precociously be aged due to bad storage conditions or/and thermal cycling i.e. repetitive captive flights. This precocious aging can generate disbonds at the various interfaces of the rocket structure or modification of the mechanical properties of the propellant. This defect or modification can be dangerous for the plane when firing the missile. A study began to build a system usable on site which allows one to know if the missile can be fired or not. The present paper gives the status of work of this study.
Derived from text
Nondestructive Tests; Solid Propellant Rocket Engines; Mechanical Properties; Thermal Cycling Tests; Missiles; Joints (Junctions)

19970034757 Royal Ordnance PLC, Kidderminster, United Kingdom
THE PENETROMETER: NON-DESTRUCTIVE TESTING OF COMPOSITE PROPELLANT ROCKET MOTOR GRAINS TO DETERMINE AGEING CHARACTERISTICS
Faulkner, G. S., Royal Ordnance PLC, UK; Thompson, A. W., Royal Ordnance PLC, UK; Buswell, H. J., Defence Research Agency, UK; May 1997; 12p; In English; See also 19970034746
Contract(s)/Grant(s): DRA-WSFH/E2096C; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

It is essential that the mechanical properties of a propellant grain are assessed during its service life to ensure that the grain has an adequate margin of safety to survive future deployment loads. The physical properties of the propellant should also be sufficient to withstand the final loading, motor pressurization on ignition. Each propellant grain can be considered unique by virtue of its manufacturing processing and its subsequent service history. In the past, it was practice to treat the population of a particular type of motor as being uniform in properties and, as such, individual motors were dissected to determine the physical properties. The obvious disadvantage to this method was that the rocket motor grain was destroyed. What was realized, however, was that the motor that had been dissected may not have been truly representative of the group to which it belonged. This dilemma was resolved by the introduction of a non-destructive test which could be applied to all the motors in the group. The Penetrometer and its usage is described within this paper.
Derived from text
Propellant Grains; Nondestructive Tests; Composite Propellants; Mechanical Properties; Service Life; Penetrometers; Aging (Materials)

19970034758 Fraunhofer-Inst. fuer Chemische Technologie, Pfinztal, Germany
THERMOGRAPHIC DETECTION OF BOND DEFECTS WITHIN MODELS OF SOLID PROPELLANT MOTORS
Schneider, H., Fraunhofer-Inst. fuer Chemische Technologie, Germany; Eisenreich, N., Fraunhofer-Inst. fuer Chemische Technologie, Germany; May 1997; 8p; In English; See also 19970034746; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Within solid propellant rocket motors there sometimes exist separations or bond defects between case and liner (insulation made of elastic polymer) or between liner and propellant. This paper demonstrates that separations or bond defects can be detected by thermography. Till now the smallest defects that could be detected had a diameter of 20 mm and a separation of 0.05 mm.
Derived from text
Solid Propellant Rocket Engines; Thermography; Linings; Bonding; Defects; Propellants; Insulation

19970034759 Thiokol Chemical Corp., Brigham City, UT United States
THE ROLE OF NDE IN SERVICE LIFE PREDICTION OF SOLID ROCKET PROPELLANT
Pearson, L. H., Thiokol Chemical Corp., USA; Doyle, T. E., Thiokol Chemical Corp., USA; Hamilton, R. S., Thiokol Chemical Corp., USA; Davis, I. L., Thiokol Chemical Corp., USA; May 1997; 12p; In English;

See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Mechanical and chemical properties of a particle filled elastomeric polymer, such as a solid rocket propellant, may change with age and contribute to the degradation of motor performance. Nondestructive evaluation (NDE) methods have been developed and tested to characterize changes in materials caused by chemical aging processes. Ultrasonic methods have been evaluated for monitoring changes in bulk propellant properties including particle dewet strength and bulk elastic properties. Theory of operation and test results for each method are reported. Some methods are applicable to full-scale rocket motors and others are intended for laboratory use to provide data for calibration and understanding.

Derived from text

Aging (Materials); Solid Rocket Propellants; Mechanical Properties; Chemical Properties; Elastomers; Nondestructive Tests; Degradation

19970034760 Societe Nationale des Poudres et Explosifs, Saint-Medard-en-Jalles, France

ESTIMATION OF THE LIFE OF SOLID PROPELLANT PROPULSION SYSTEMS: PERSPECTIVES OFFERED FOR THE USE OF HIGH DENSITY TOMOGRAPHY *ESTIMATION DE LA DUREE DE VIE DES SYSTEMES PROPULSIFS A PROPERGOL SOLIDE: PERSPECTIVES OFFERTES PAR L'UTILISATION DE LA TOMOGRAPHIE HAUTE ENERGIE*

Lamarque, P., Societe Nationale des Poudres et Explosifs, France; Tauzia, J. M., Societe Nationale des Poudres et Explosifs, France; May 1997; 6p; In French; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The assessment of the safe and nominal operability of solid rocket motors after a long period in storage or in operational carriers is a constant concern of users. Whilst numerous techniques have been proposed for that purpose, none has proved to be fully satisfactory. Traditional X-ray analysis provides useful, but insufficient results. High density computed tomography, a powerful non-invasive means of investigation, has become over the last decade, thanks to its unique performance, the major tool for shelf life assessment, especially in the U.S.A. DOD sponsored research has been carried out in this field in France. This paper summarizes the results obtained regarding the specific equipment (sensors, measurements) and the performances measured. From the results available, tomographic images can be considered as providing an identity card of the motor, enabling its monitoring in time.

Derived from text

Tomography; Propulsion System Performance; Service Life; Solid Propellant Rocket Engines; Storage Stability; Propulsion System Configurations; Estimating

19970034761 Naval Surface Warfare Center, Indian Head, MD United States

IMMERSION ULTRASONIC ANALYSIS OF EXTRUDED ROCKET MOTORS

Glowacki, Leon M., Naval Surface Warfare Center, USA; May 1997; 10p; In English; See also 19970034746; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Indian Head Division of the Naval Surface Warfare Center, in Indian Head, Maryland, U.S.A., has an ultrasonic system capable of volumetrically evaluating small diameter rocket motor propellant grains. The ultrasonic system and the evaluation technique described in this paper are used to inspect a specific weapon system component. With minor modifications the system and technique can be used to inspect a wide variety of extruded rocket motor propellant grains. In this evaluation the propellant grains are extruded and tape wrapped prior to inspection. The grains may be evaluated however, in an as extruded condition. The grains are approximately 2.6 inches in diameter, approximately 3 feet in length and contain an eight point star bore. The star bore, formed during the extrusion process, is made by forcing a propellant blank or carpet roll through a cross shaped center stake support. The center stake support sections the blank into four quadrants. With a combination of pressure, speed, vacuum and temperature the four quadrants are extruded down onto the eight pointed star shaped center stake. The extrusion process parameters are very critical and any variation in temperature, speed, pressure or vacuum can result in the introduction of discontinuities.

Derived from text

Rocket Engines; Extruding; Ultrasonic Tests; Propellant Grains; Weapon Systems; Inspection

19970034762 Naval Surface Warfare Center, Indian Head, MD United States

OVERVIEW OF THE UNITED STATES ARMY AND NAVY GUN PROPELLANT SAFETY SURVEILLANCE PROGRAMS

Lee, D. D., Naval Surface Warfare Center, USA; Stine, G. Y., Naval Surface Warfare Center, USA; Robertson, D. G., Army Research Development and Engineering Center, USA; Ark, W. F., Army Research Development and Engineering Center, USA; May 1997; 14p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The USA Army, the U.S. Navy, and the U.S. Marine Corps each conduct safety surveillance programs to monitor the stability of their gun propellants that are nitrate ester-based. This paper provides an overview of the efforts from those programs. The paper discusses the rationale behind current test programs and test techniques. The paper provides some "lessons learned" from previous techniques and provides some information on the efforts of the programs during the past five years.

Derived from text

Gun Propellants; Safety; Nitrate Esters; Surveillance; Stability; Navy; Military Technology; Armed Forces (USA)

19970034763 Bundesinstitut fuer Chemisch-Technische Untersuchgen, Swisttal-Heimerzheim, Germany

FORMER AND MODERN METHODS FOR THE DETERMINATION OF THE SERVICE LIFE OF ROCKET PROPELLANTS

Holl, G., Bundesinstitut fuer Chemisch-Technische Untersuchgen, Germany; Wilker, S., Bundesinstitut fuer Chemisch-Technische Untersuchgen, Germany; Kaiser, M., Bundesinstitut fuer Chemisch-Technische Untersuchgen, Germany; Guillaume, P., Patscentre Benelux Clermont S.A., Belgium; May 1997; 14p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Different methods that are nowadays used to determine the service life of a propellant are briefly introduced and discussed. In the second part selected results of classical high temperature tests, heat flow calorimetry, stabilizer consumption and molecular mass depletion as well as NMR experiments are presented. In summary it can be stated, that only a combination of many different methods allow to make predictions of the ballistic life time of a propellant. to do this still a huge amount of experiments must be done to define the "allowable" limits of energy loss, of stabilizer consumption, of migration processes or changes in mechanical properties.

Author

Rocket Propellants; Service Life; High Temperature Tests; Heat Transmission; Nuclear Magnetic Resonance; Heat Measurement

19970034764 Etablissement Technique de Bourges, Lab. Poudres et Explosifs, France

CORRELATION BETWEEN STABILITY RESULTS OF GUN PROPELLANTS OBTAINED AFTER ARTIFICIAL AGEING AT 50 C AND NATURAL AGEING *CORRELATION ENTRE LES RESULTATS DE STABILITE DE POUDRES POUR ARMES OBTENUS APRES VIELLISSEMENT ARTIFICIEL A 50 C ET CEUX OBTENUS EN VIEILLISSEMENT NATUREL*

Ruault, O., Etablissement Technique de Bourges, France; Bales, C., Etablissement Technique de Bourges, France; May 1997; 8p; In French; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

France has devised in 1975 a stability test based on decrease of stabilizer after 6 weeks at 50 C. The aim of this test is to predict if a new propellant will give a good guarantee of conservation. The test has been used for 20 years on single base propellants made with diphenylamine. Now it's possible to prove the validity of this test by studying

the results obtained after natural aging and results obtained with this test. We can also show that tests, based on artificial aging at higher temperatures, are not representative.
Author
Gun Propellants; Aging (Materials); Stability Tests; Predictions; Conservation

19970034765 Fraunhofer-Inst. fuer Chemische Technologie, Pfinztal, Germany
AGEING BEHAVIOUR OF PROPELLANTS DETERMINED BY MASS LOSS, HEAT GENERATION, STABILIZER CONSUMPTION AND MOLAR MASS DECREASE
Volk, Fred, Fraunhofer-Inst. fuer Chemische Technologie, Germany; Bohn, Manfred A., Fraunhofer-Inst. fuer Chemische Technologie, Germany; May 1997; 14p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

During the service life of nitric acid ester based propellants a consumption of stabilizer and a degradation of the mean molar (molecular) masses such as number average Mn, mass average Mw and Z-average Mz of the nitrocellulose occur due to decomposition reactions. Therefore the chemical and mechanical properties of the propellants are changed and the safe service life and the safe storage time, the so-called lifetimes, are limited. In order to predict the lifetimes one needs to measure properties P, which are changed by the decomposition reactions in the propellant and which can be determined with good accuracy as a function of time and temperature, if necessary also in dependence of further variables. For propellants consisting of nitric acid esters, stabilizer consumption, molar mass degradation and mass loss are very suitable properties. Heat generation measured by heat flux microcalorimeters is an assessment of the momentary reaction rate. The stabilizer content was measured by reversed-phase high performance liquid chromatography (HPLC), the molar mass degradation by gel permeation chromatography (GPC), the heat generation was determined by a microcalorimeter and the mass loss with an analytical balance. For the evaluation of the experimental data kinetic models are used. The molar mass decrease is reproduced very well by a model, which assumes a statistical chain scission by the decomposition of chain elements. Stabilizer consumption is described with two models, one is based on a reaction of first order, the other one is a combination of first and zero order reactions. With these kinetic descriptions lifetime predictions are made. This is done for single temperatures and for three temperature-time profiles, two from STANAG 2895 and one from the industry. The mass loss and the heat generation measurements show the autocatalytic acceleration of the decomposition reactions for some gun propellants and for nitrocellulose and corresponding autocatalytic kinetic models are used for the mathematical description of the data. The pre-autocatalytic aging can be evaluated by a reaction of zero order and results are given for the heat generation of a double and a triple base gun propellant The linear mass loss increase is compared between five German gun propellants (GP) and the energetic binder GAP. The gun propellants are: single base A5020, single base K503, single base (with DNT) CD5240 (US M6), double base L5460 (US JA2) and triple base KN6540 (US M30).
Author
Aging (Materials); Nitric Acid; Esters; Cellulose Nitrate; Mechanical Properties; Chemical Properties; Service Life; Decomposition; Propellants; Time Temperature Parameter; Binders (Materials)

19970034766 Army Research Lab., Aberdeen Proving Ground, MD United States
LOVA PROPELLANT AGING: EFFECT OF RESIDUAL SOLVENT
Pesce-Rodriguez, R. A., Army Research Lab., USA; Fifer, R. A., Army Research Lab., USA; May 1997; 10p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

An investigation of LOVA propellant aging was performed to identify the cause of stabilization periods in certain propellant lots. Two important observations were made: (1) the level of residual solvent in propellant grains slowly decreases while in storage; and (2) during the drying process and while the grains are in storage in storage, plasticizer "co-migrates" with solvent, resulting in plasticizer accumulation at grain surfaces. It was also observed that while in storage, residual solvent may be oxidized to generate organic acids. Based on these results, it is proposed that stabilization periods result from processes related to migration, evaporation, and oxidation of residual solvent.
Author
Aging (Materials); Stabilization; Propellant Grains; Propellant Storability; Plasticizers; Solvents; Drying

19970034767 Societe Nationale des Poudres et Explosifs, Div. Preparation du Futur et Propulsion, Vert-Le-Petit, France
COMPARATIVE EVALUATION OF THE LIFETIME OF COMPOSITE AND SIMPLE BASE PROPELLANTS *EVALUATION COMPAREE DE LA DUREE DE VIE DE POUDRES COMPOSITES ET SIMPLE BASE*
Rat, Mauricette, Societe Nationale des Poudres et Explosifs, France; May 1997; 8p; In French; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper presents the works carried out by SNPE to meet the specifications (chemical stability, ballistic stability at high temperature, lifetime) required for a medium caliber ammunition for aircraft. The behavior of industrial gun propellant has been improved by optimizing the properties of the nitrocellulosic matrix. Yet this solution is limited because of the chemical stability of nitrocellulose. So, SNPE has proposed composite gun propellants based on an inert or energetic binder filled with nitramine (RDX). Their thermal properties and their lifetime will be discussed and compared to those of single base gun propellants.
Author
Ballistics; Ammunition; Stability; Aircraft; Cellulose Nitrate; Gun Propellants; Composite Propellants; High Temperature

19970034768 Defence Research Establishment Valcartier, Courcellette, Quebec Canada
THE CANADIAN GUN PROPELLANT SURVEILLANCE PROGRAM
Lussier, L. S., Defence Research Establishment Valcartier, Canada; Gagnon, H., Defence Research Establishment Valcartier, Canada; May 1997; 4p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

This paper describes the work done at DREV to develop modern methods of monitoring the chemical stability and remaining safe life of gun powders stocked by the Canadian Forces (CF). It begins with the rationale behind the choice of high-performance liquid chromatography (HPLC), as well as the criteria the HPLC methods must meet. This is followed by a description of the development of two fast, reliable and efficient methods. Finally, the role of N-NO-DPA as a stabilizer and the sentencing criteria are discussed.
Author
Gun Propellants; Stability; Chemical Properties; Surveillance; Canada

19970034769 Royal Ordnance PLC, Kidderminster, United Kingdom
SERVICE LIFE PREDICTION METHODOLOGIES ASPECTS OF THE TTCP KTA-14 UK PROGRAMME
Faulkner, G. S., Royal Ordnance PLC, UK; Tod, D., Defence Research Agency, UK; May 1997; 14p; In English; See also 19970034746
Contract(s)/Grant(s): DRA-WSFH/E2096C; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

At the 12th meeting of The Technical Cooperation Program (TTCP), Panel W-4, Propulsion Technology, participants from the USA and the United Kingdom jointly proposed a collaborative program within TTCP. The aims of this program were to improve experimental methods and attempt to validate current predictive service life methodologies. A decision was taken to evaluate solid rocket motor propellants containing HTPB propellants. All the participants fielded motors that were instrumented and then subjected them to agreed programs of work. In September 1988, formal approval was received and the collaborative program became Key Technical Area 14 (KTA-14). Canada, Australia, the UK and the US all fielded motors for the program. This paper outlines some of the results from the work carried out in the UK by Royal Ordnance Rocket Motors and the Defense Research Agency Fort Halstead.
Derived from text
Service Life; Predictions; HTPB Propellants; Rocket Propellants; Solid Propellant Rocket Engines; Prediction Analysis Techniques; Life (Durability)

19970034770 Micron Instruments, Simi Valley, CA United States
MINIATURE SENSOR FOR MEASURING SOLID GRAIN ROCKET MOTOR CASE BOND STRESS
Chelner, Herb, Micron Instruments, USA; Buswell, J., Defence Research Agency, UK; May 1997; 12p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Solid propellant normal bond stress profiles are calculated and used in the predication of motor service and storage life. Bond stresses are calculated instead of measured due to the belief that making the measurement is difficult and available sensors too inaccurate. Recent developments in stress measurement technology and instrumentation has changed that situation completely. This reported work has resulted in the design of a miniature sensor with improved accuracy and stability and which is more easily installed in rocket motors with minimal effect on the grain stress distribution. The design goal for thermal hysteresis, when thermally cycled between -45 C to +65 C was 7 kPa (1 psi). Sensors with less that 3 kPa (+/-0.5 psi) were produced but the yield needs to be improved. The long term stability design goal of 7 kPa (1.0 psi) per year was exceeded. The average drift of all sensors tested was less than 5 kPa (0.7 psi) per year with many sensors drifting less than 2 kPa (0.25 psi) per year. For ease of installation the low flat miniature profile with a diameter of 7.6 mm and a 2.0 mm thickness fits easily into the motor lining or may be bonded to the case wall. A 1.0 mm hole is required for the 5 conductor cable which can be disconnected from the remote bridge completion package for installation and routing without soldering. The remote bridge completion housing comes complete with water seals on the cable, top cover and electrical connector.
Derived from text
Sensors; Solid Propellants; Predictions; Storage Stability; Service Life; Bonding; Stress Measurement; Stress Distribution; Case Bonded Propellants; Miniaturization

19970034771 Defence Research Establishment Valcartier, Courcellette, Quebec Canada
VERIFICATION OF THE SWANSON NONLINEAR THERMO-VISCOELASTIC MODEL USING STRESS GAGE TECHNOLOGY
Wong, F. C., Defence Research Establishment Valcartier, Canada; Firmin, A., H. G. Engineering Ltd., Canada; Liu, Y. C., H. G. Engineering Ltd., Canada; May 1997; 14p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Solid propellants must function as a structural member as well as an energy source. They must deform without failing under thermal, acceleration and pressurization conditions. Structural failure by cracking is usually catastrophic since the advancing flame front propagates into any exposed surface. Therefore, the ability to predict the stress-strain state of a propellant is critical to the establishment of a motor's operational limits. Stress prediction for propellants is complicated by the fact that this material exhibits nonlinear viscoelastic characteristics. This paper summarizes the development of a modified Swanson constitutive model for use in the finite element program ABAQUS. Predictions of propellant behavior for three uniaxial test cases and one three-dimensional test case are made and compared to experimental results. The uniaxial test cases cover the propellant's stress response to straining-cooling and thermal shock environments. Measurements from an instrumented rocket motor placed in a thermal shock environment provide the data for evaluating the three-dimensional prediction capabilities of the ABAQUS implementation. It will be shown that the modified Swanson model can predict nonlinear viscoelastic behavior correctly but to be used for solid rocket motor service life methodologies, the model still requires some calibration using in-situ measurements from an instrumented rocket motor.
Derived from text
Mathematical Models; Solid Propellants; Structural Members; Stress-Strain Relationships; Predictions; Finite Element Method; Viscoelasticity; Measuring Instruments; Structural Failure

19970034772 Viscoelastic Materials Services, Tucson, AZ United States
IMPROVEMENTS IN ROCKET MOTOR SERVICE LIFE PREDICTION
Francis, Eugene C., Viscoelastic Materials Services, USA; Buswell, H. J., Defence Research Agency, UK; Service Life of Solid Propellant Systems; May 1997; 14p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Rocket motor service life predictions have always been compromised by the nonlinear viscoelastic behavior of the highly filled solid propellants. These nonlinearities include damage and rehealing which are dependent on the thermal loading histories and stress axialities in the grain. Recent work to eliminate some of these analytic uncertainties has led to the development of improved experimental stress analysis methods based on actual measured rocket motor bond stresses. A third generation of miniature bond line stress sensors have been fabricated which have increased accuracy, stability and can be used for in-situ health monitoring of tactical motors. The use of these units in service life programs has already measured the time dependency and nonlinearities which are exhibited in typical laboratory tests on solid propellants. These measurements can be used to correct the stress analysis output and hence lead to more accurate structural integrity calculations. The major objective of this new technology is the reliable prediction of safe service life giving a more cost effective missile replacement policy.
Derived from text
Service Life; Predictions; Rocket Engines; Solid Propellants; Viscoelasticity; Nonlinear Systems; Damage; Thermal Stresses; Stress Analysis

19970034773 Defence Science and Technology Organisation, Weapons Systems Div., Salisbury, Australia
INSTRUMENTED SERVICE LIFE PROGRAM FOR THE PICTOR ROCKET MOTOR
Ho, S. Y., Defence Science and Technology Organisation, Australia; Ide, K., Defence Science and Technology Organisation, Australia; Macdowell, P., Defence Science and Technology Organisation, Australia; May 1997; 8p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes a Solid Propellant Rocket Motor Service Life program conducted at the Aeronautical and Maritime Research Laboratory/ DSTO, which combined a nonlinear viscoelastic analysis of an Australian R&D motor, Pictor, and used miniature embedded stress transducers to validate analysis and/or define the actual stresses in the rocket motor during various thermal loading conditions (thermal shock, thermal cycling, accelerated aging and ambient aging). The measured stresses during solid propellant rocket motor thermal cycling were obtained for comparison with linear elastic/ viscoelastic and nonlinear viscoelastic finite element analysis. Measurements are in reasonable agreement with nonlinear viscoelastic analysis for most motor loading conditions. Capabilities for modified Fracture Mechanics and non-linear viscoelastic analysis were incorporated into a commercial general purpose finite element (FE) code, STRAND 6.1. The thermal stresses induced in the motors were modeled using this FE code. The code was also developed to calculate the critical crack length for propagation during thermal transients. Uniaxial and biaxial tension, and bond-in-tension tests were conducted for the failure analysis. Additionally, a modified Fracture Mechanics approach was used to obtain the fracture energy (G(sub c)) as an alternative failure criterion and also to determine the critical crack length for propagation.
Derived from text
Service Life; Rocket Engines; Nonlinearity; Viscoelasticity; Accelerated Life Tests; Aging (Materials); Failure Analysis; Stress Analysis; Thermal Shock; Thermal Cycling Tests; Finite Element Method

19970034774 Thiokol Corp., Brigham City, UT United States
SOLID ROCKET MOTOR SERVICE LIFE PREDICTION USING NONLINEAR VISCOELASTIC ANALYSIS AND A PROBABILISTIC APPROACH
Collingwood, Gerald A., Thiokol Corp., USA; Dixon, Michael D., Thiokol Corp., USA; Clark, Laurie M., Utah State Univ., USA; Becker, Eric B., Texas Univ., USA; May 1997; 8p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Three critical factors were used to determine the Service Life Estimate for a solid rocket motor. First, the material property aging trends over time were evaluated. Second, an accurate structural analysis was performed. In this work, Nonlinear Viscoelastic (NLVE) analysis techniques were used to provide the most accurate assessment of propellant behavior. Finally, a probabilistic approach was applied, incorporating test data, aging trends, and variations of input parame-

ters to obtain the service life. Development of the approach included an evaluation of various NLVE constitutive theories and their verification in laboratory tests using subscale motors. The approach was applied to a solid rocket motor using 3D NLVE analysis and the probabilistic service life estimate methodology.
Author
Solid Propellant Rocket Engines; Aging (Materials); Service Life; Structural Analysis; Life (Durability); Nonlinearity; Trends

19970034775 Phillips Lab., Kirtland AFB, NM United States
INTRINSIC STRENGTH OF SOLID PROPELLANT BOND SYSTEMS: STRESS-STRAIN BEHAVIOR BIT-IN-TENSION WITH RUBBER MATERIALS
Slivinsky, Sandra H., Phillips Lab., USA; Kugler, H. Peter, Fiedler Optoelektronik G.m.b.H., Germany; Drude, Harry, Fiedler Optoelektronik G.m.b.H., Germany; May 1997; 14p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The deformation of bonded rubber samples is studied through use of an opto-electrical system, consisting of electronics, optics, and software. The system makes it possible to determine the stress-strain behavior of specimens tested in a tensile tester. Measurements are unique in that detailed localized information becomes available so that particular deformation behavior can be studied. The test series being reported was performed as a design of experiments so that a statistical analysis of variance could be applied to the results. The parameters studied were rubber flexibility, thickness, and order of sample stacking. Sample test data and the complete analysis of variance are presented, resulting in generalized equations for the parameters tested.
Author
Bonding; Solid Propellants; Rubber; Deformation; Stress-Strain Relationships; Statistical Analysis; Experiment Design; Analysis of Variance; Tensile Tests

19970034776 Prins Maurits Lab. TNO, Rijswijk, Netherlands
STRUCTURAL SERVICE LIFETIME MODELLING FOR SOLID PROPELLANT ROCKET MOTORS
Keizers, H. L. J., Prins Maurits Lab. TNO, Netherlands; Miedema, J. R., Prins Maurits Lab. TNO, Netherlands; May 1997; 8p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

An approach of the structural service lifetime problem of solid propellant rocket motors is presented, based on a combination of experimental and theoretical techniques. It includes propellant aging research, monitoring and non-destructive testing of life motors, dissectioning of motors, testing of the propellants, accelerated aging techniques, static firings and computer modeling incorporating aging effects. Typical aging results regarding chemical and mechanical aging of composite propellants are shown. Preliminary lifetime prediction models are used to give insight in the available rest life of a rocket motor. For an accurate lifetime prediction it is important to have insight in the initial propellant properties, aging characteristics, motor design and environmental history of the motor.
Derived from text
Service Life; Accelerated Life Tests; Aging (Materials); Solid Propellant Rocket Engines; Nondestructive Tests; Computerized Simulation

19970034777 Instituto Nacional de Tecnica Aeroespacial, Dept. of Rocket Motors, Madrid, Spain
AGING STUDIES ON HTPB PROPELLANTS BY DYNAMIC MECHANICAL ANALYSIS
Schueller, Carlos, Instituto Nacional de Tecnica Aeroespacial, Spain; delaFuente, Jose Luis, Instituto Nacional de Tecnica Aeroespacial, Spain; May 1997; 10p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Aging studies on hydroxyl terminated polybutadiene (HTPB) propellants have been carried out. The change in the mechanical properties have been measured using a Dynamic Mechanical Analyzer DMA operating in two different modes: frequency scan and temperature scan. This technique allows evaluation of the actual state of a propellant grain with a small sample and an easy measurement.
Derived from text
HTPB Propellants; Aging (Materials); Mechanical Properties; Polybutadiene; Propellant Grains

19970034778 Virginia Polytechnic Inst. and State Univ., Blacksburg, VA United States
PROBABILISTIC SERVICE LIFE PREDICTION FOR SOLID PROPELLANT MOTORS SUBJECTED TO ENVIRONMENTAL THERMAL LOADS
Heller, R. A., Virginia Polytechnic Inst. and State Univ., USA; Thangjitham, S., Virginia Polytechnic Inst. and State Univ., USA; Janajreh, I. M., Michelin Americas Research Corp., USA; May 1997; 12p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Tactical solid propellant rocket motors stored under field conditions are subjected to environmental temperature variations and, as a consequence, to variable thermal stresses. These stresses may, during the service life of the motor, exceed the cumulatively damaged strength of the propellant resulting in cracks that could induce failure upon firing. Because both temperature and material properties are random variables, service life calculations should be based on probabilistic considerations, i.e., motor life is to be terminated when the progressive probability of failure which increases with elapsed time exceeds a predetermined value.
Derived from text
Service Life; Solid Propellant Rocket Engines; Life (Durability); Thermal Stresses; Predictions

19970034779 GenCorp Aerojet, Sacramento, CA United States
METHODOLOGY AND TECHNIQUES FOR DETERMINING SERVICE LIFE OF SOLID ROCKET MOTORS
McCamey, Richard K., GenCorp Aerojet, USA; Liu, Edmund K. S., GenCorp Aerojet, USA; May 1997; 10p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

One methodology in common use today for evaluating service life is based on chemical kinetic models quantified by the rate theory of Eyring and the Arrhenius relationship. Techniques employed to accomplish this task may include mechanism studies as well as kinetic evaluation of material property changes. Verification of aging trends and models may be accomplished through motor dissections, plug motors, and excised samples. This methodology and associated techniques will be discussed in depth.
Author
Methodology; Service Life; Solid Propellant Rocket Engines; Mechanical Properties; Reaction Kinetics

19970034780 Defence Research Consultancy, Westcott, United Kingdom
SERVICE LIFE PREDICTION OF SOLID ROCKET PROPELLANT MOTORS STORED IN A RANDOM THERMAL ENVIRONMENT
Margetson, J., Defence Research Consultancy, UK; Wong, F. C., Defence Research Establishment Valcartier, Canada; May 1997; 12p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A service life prediction analysis is developed for solid propellant rocket motors which are stored under statistically varying environmental conditions. Monitoring devices are used to measure the statistically varying stresses and strains which are induced as a result of the statistically varying diurnal and seasonal thermal cycles. A failure probability analysis is used to determine the probability that the statistically varying time dependent stress (strain) exceeds the statistically varying strength (strain capacity) of the propellant. A time dependent failure probability growth relationship is used to determine the time taken for the failure probability to increase to a specified unacceptable level. This time denotes the service life. The probabilistic service life prediction analysis is applied to an instrumented rocket motor stored

at the environmental site at Valcartier, Canada. The results are compared with the service life predictions derived from a deterministic structural analysis approach.
Derived from text
Service Life; Predictions; Solid Propellant Rocket Engines; Thermal Environments; Life (Durability); Time Dependence; Stress-Strain Relationships; Failure Analysis; Diurnal Variations

19970034781 Laboratorio Quimico Central de Armamento, Madrid, Spain
PREDICTION OF THE SHELF LIFE OF MUNITIONS: BALLISTIC AND CHEMICAL PROPERTIES
JenarodeMencos, G., Laboratorio Quimico Central de Armamento, Spain; Tamayo, J. Hernandez, Laboratorio Quimico Central de Armamento, Spain; May 1997; 14p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A correlated experiment between stabilizer consumption in the propellant and ballistic properties of a solid rocket motor, which include the same propellant, has been performed. Results have showed that ballistic properties can change substantially before the stabilizer has been consumed. Previously propellant was analyzed and compared with other propellants. These are four homogeneous rocket propellants which were tested to find out stabilizer consumption during two years artificial aging at 50 C. All propellants had a previous natural aging of between 10 and 27 years. Ballistic properties were measured during a series of firings in rocket motor test stand. Propellant samples and solid rocket motor have been subjected to the same aging test.
Derived from text
Chemical Properties; Service Life; Storage Stability; Solid Propellant Rocket Engines; Propellant Properties; Ballistics; Aging (Materials)

19970034782 Defence Research Agency, Fort Halstead, United Kingdom
ENVIRONMENTAL DATA FOR ROCKET MOTOR SERVICE LIFE ASSESSMENT
Maxey, I. H., Defence Research Agency, UK; May 1997; 14p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Descriptions are given of the various NATO standards and specifications for the environmental aspects in the service life cycle. Details are given of the differing climatic and mechanical loads related to the individual elements in the manufacture-to-target sequence within the life cycle of the rocket motor for tactical missiles. Aspects concerning the use of extreme conditions and measured data are related to the storage and operational use phases in the differing life cycles of land, sea and air forces' tactical missiles. The main considerations and limitations during environmental testing programs are discussed. The use of modern methods of data capture and analysis are recommended.
Derived from text
Rocket Engines; Service Life; Specifications; Standards; North Atlantic Treaty Organization (NATO); Loads (Forces); Climatology; Environment Effects

19970034783 CELERG, Saint-Medard-en-Jalles, France
EVALUATION OF THE SERVICE LIFE OF TACTICAL MOTORS *EVALUATION DE LA DUREE DE VIE DES MOTEURS TACTIQUES*
Herran, B., CELERG, France; Nugeyre, J. C., CELERG, France; May 1997; 14p; In French; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents two different methods for tactical service life prediction. In the first approach, called Simulated Natural Aging (S.N.A), the evaluation of aging effects on physical properties and performances of Rocket Motor is performed through specific short time aging programs, simulating long term storage and field conditions. In the second approach, S.N.A programs are conducted on case bonded Rocket Motors analogs. Dissections provide convenient results used in reliability predictions as a function of aging time. The comparison with reliability requirements makes possible the Rocket Motor service life prediction. The second approach can be used if the main aging risk is identified and if the modelization is possible.
Derived from text
Aging (Materials); Service Life; Predictions; Performance Prediction; Reliability Analysis; Rocket Engines; Case Bonded Propellants; Life (Durability)

19970034784 Fraunhofer-Inst. fuer Chemische Technologie, Pfinztal, Germany
SERVICE LIFE DETERMINATION OF ROCKET MOTORS BY COMPREHENSIVE PROPERTY ANALYSIS OF PROPELLANT GRAINS
Schubert, Hiltmar, Fraunhofer-Inst. fuer Chemische Technologie, Germany; Menke, Klaus, Fraunhofer-Inst. fuer Chemische Technologie, Germany; May 1997; 10p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Over three decades ICT and the first author of this paper were engaged in research of the aging behavior of propellants and the life time prediction of rocket propellant grains. In the context of these R + D activities test methods were created or known procedures were improved for special application. These methods were used to predict the service life determination of rocket motors, which were in service for many years in NATO countries. Starting with some definitions about life time the most important physical and chemical aging phenomena for the different propellant types and their influence of the life time of the grain were described and their effects discussed. The knowledge of the time depending on aging behavior will be the fundament of the simulation procedure to evaluate the predicted life time of a system. to safe expenses and time, for the investigations to predict life time a tailoring principle is used. This method collects all stresses which the weapon system has to overcome during the whole future life time, including all pretreatments. Outgoing from these data a tailored simulation will be performed to fix the predicted service life time.
Derived from text
Service Life; Rocket Engines; Propellant Grains; Life (Durability); Predictions; Aging (Materials); Rocket Propellants

19970034786 Royal Ordnance PLC, Kidderminster, United Kingdom
CHEMICAL SAFE LIFE PREDICTIONS FOR CAST DOUBLE BASE ROCKET PROPELLANTS
Sloan, M. P., Royal Ordnance PLC, UK; Salsbury, S. J., Royal Ordnance PLC, UK; Keeton, G. M., Royal Ordnance PLC, UK; May 1997; 10p; In English; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The chemical stabilizer depletion rates of a number of Cast Double Base (CDB) propellants have been investigated by aging at elevated temperatures. New values for the activation energy for para-nitro-N-methylaniline (pNMA) degradation have been calculated for formulations containing both lead and copper based ballistic modifier systems. These have been used to generate predictions of depletion during natural storage of service motors. These predictions were accurate within the limits imposed by the absence of detailed thermal history for the test rounds. Suggestions for future study are made.
Derived from text
Predictions; Double Base Rocket Propellants; Activation Energy; Degradation; Aging (Materials); Copper; Lead (Metal)

19970034787 Societe Europeenne de Propulsion, Saint-Medard-en-Jalles, France
OPERATIONAL CONSTRAINTS AND OPERATING LIFE OF PROPULSION SYSTEMS FOR TACTICAL MISSILES: PARTICULAR FEATURES OF COMPOSITE STRUCTURE PROPULSION UNITS *CONTRAINTES OPERATIONNELLES ET DUREE DE VIE DES SYSTEMES PROPULSIFS POUR MISSILES TACTIQUES: PARTICULARITES DES PROPULSEURS A STRUCTURE COMPOSITE*
Laurencon, Norbert, Societe Europeenne de Propulsion, France; May 1997; 10p; In French; See also 19970034746; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Between 1970 and 1980 the SEP conducted many tests allowing one to describe and test the use of composite materials on propulsion systems used for strategic, pre-strategic and tactical missiles. Between 1980 and 1988 the SEP was also involved in the development of propulsion systems for S530D and Mistral missiles. It thus acquired a great deal of experience pertaining to the constraints recorded during the operational life of tactical missile propulsion units. Their consideration in the development of engines allowed them to improve and adjust performance features of materials and architectures for the propulsion systems. In this report we first present the structural assembly method used for the production of S530D and

Mistral propulsion units considering its particular features and its possible influence on the obsolescence of propulsion systems that use glass, Kevlar, and carbon wound structures.
Author
Service Life; Propulsion System Performance; Missiles; Composite Structures; Propulsion System Configurations; Engine Tests

19970034788 Aerospatiale Missiles, Chatillon, France
GENERAL PROGRAM FOR TESTING AGING. APPLICATION TO AN AIR-SOL MISSILE ***PROGRAMME GENERAL D'ESSAIS DE VIEILLISSEMENT APPLICATION A UN MISSILE AIR-SOL***
Chevalier, Alain, Aerospatiale Missiles, France; Laurent, Jean Marie, CELERG, France; May 1997; 16p; In French; See also 19970034746; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The purpose of the aging tests is to perform a regular monitoring of the development of the weapon system's performances and characteristics in the course of time in order that performances and the contractual availabilities during the whole lifetime of the system can be guaranteed so as to initiate early enough preservation actions which might become necessary (recycling, manufacture of new equipment) in case life of some equipment should expire before the planned time limit. Three important test and aging categories can make the above monitoring possible: accelerated aging tests; real natural aging tests; and simulated natural aging tests. This conference presents the choice made as well as the principles and the content of the test program considered for the accelerator of an air to surface missile.
Author
Aging (Materials); Air to Surface Missiles; Accelerated Life Tests; Weapon Systems; Recycling

19980018705 Alenia Spazio S.p.A., Turin, Italy
INTEGRATED HYDROGEN FUEL MANAGEMENT AS HEAT SINK FOR ACTIVE COOLING IN ADVANCED HYPERSONIC AIRCRAFT
Denaro, A., Alenia Spazio S.p.A., Italy; Audrito, G., Alenia Spazio S.p.A., Italy; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 8p; In English; See also 19980018672; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Cooling potentialities of hydrogen fuel to manage the heat dissipations of internal equipment are explored and integrated with the complete Thermal Control System of a reference hypersonic vehicle. Nominal performances are investigated during all a mission phase and drivers are provided for the optimization of the Regenerative Cooling. Derived from text
Cooling; Management Systems; Hydrogen Fuels; Hypersonic Aircraft; Regenerative Cooling; Hypersonic Vehicles

19980206035 Societe Nationale des Poudres et Explosifs, Direction des Operations Scientifiques et Technologiques, Saint-Medard-en-Jalles, France
SOLID ROCKET PROPELLANT BEHAVIOR DURING STATIC FIRING TEST USING REAL TIME X-RAY RADIOSCOPY
Tauzia, J. M., Societe Nationale des Poudres et Explosifs, France; Lamarque, P., Societe Nationale des Poudres et Explosifs, France; May 1998; 6p; In French; See also 19980206002; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Unlike ordinary motors, solid propellants rockets operate only once and for a very short period of time. So, a method able to investigate the behavior of the grain during static firing test is of high interest for the people in charge of the development program especially regarding the following phases: ignition, burning surface Propagation, and defects behavior and motors failure modes. The connection of high speed video camera with real time x ray equipment allows valuable data acquisition during the firing and fulfill the need of direct investigation of the related phenomenon. In this paper some examples are presented, analyzed, and compared with computed simulation.
Author
Solid Rocket Propellants; Solid Propellant Rocket Engines; Static Firing; X Ray Analysis; Propellant Combustion; Real Time Operation; Propellant Properties

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ENGINEERING (GENERAL)

19950025702 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
GUIDANCE AND CONTROL FOR FUTURE AIR-DEFENCE SYSTEMS ***TECHNIQUES DE GUIDAGE/PILOTAGE POUR LES SYSTEMES FUTURS DE DEFENCE ANTI-AERIENNE***
Jan 1, 1995; 202p; In English; In French; See also 19950025703 through 19950025720
Report No.(s): AGARD-CP-555; ISBN 92-836-0008-8; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

This volume contains the Technical Evaluation Report and the 18 unclassified papers, presented at the Mission Systems Panel Symposium held in Copenhagen, Denmark from 17th to 20th May 1994. The papers presented covered the following headings: (1) Ballistic Missile Defense Architecture and Air Defense Simulation; (2) Advanced Sensors Technology and Techniques; (3) Acquisition, Pointing, Fire Control and System Integration (4) Data Fusion, Tracking and Identification; (5) Threat Detection, Suppression and Situation Assessment; (6) Missile Guidance and Control; and (7) C3I Aspects.
Air Defense; Command and Control; Command Guidance; Conferences; Electronic Control; Electronic Warfare; Fire Control; Guidance Sensors; Man Machine Systems; Missile Control; Missile Defense; Pointing Control Systems; Space Based Radar

19950025703 North Atlantic Treaty Organization, NATO Industrial Advisory Group., Brussels, Belgium
STUDY OF EXTENDED AIR DEFENCE POST 2000
Mantle, Peter J., North Atlantic Treaty Organization, Belgium; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 16 p; In English; See also 19950025702; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This invited paper, which was the second oral presentation at the conference, covered the conclusions found by NIAG SG-37 during a one year research of the issues and solutions to furnishing extended air defense capability to NATO and its forces. Key issues diagnosed included: (1) the requirement of a multi-layered defense system that includes space-based defense, aircraft, missiles, and other hardware; (2) the electronics needed for this support; and (3) the materials, propulsion devices, and lethality of the systems. A technological forecast of funding recommendations is included.
CASI
Air Defense; Command and Control; Cost Analysis; North Atlantic Treaty Organization (NATO); Technological Forecasting; Technology Assessment; Warfare

19950025704 GIE Cosyde, Velizy-Villacoublay, France
DEFINITION OF AN ANTI-MISSILE BALLISTIC DEFENSE ARCHITECTURE FOR EUROPE ***DEFINITION D'UNE ARCHITECTURE DE DEFENSE ANTI-MISSILE BALISTIQUE POUR L'EUROPE***
Deas, M., GIE Cosyde, France; Tanter, A., GIE Cosyde, France; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 7 p; In French; See also 19950025702; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The end of the Seventies and beginning of the Eighties showed significant technological developments in ballistic missiles, in particular,impact precision. These improvements caused Western strategists to be concerned with use of ballistic missiles equipped with conventional loads against military objectives (the Pact of Varsovie). The concept of ballistic missile tactical had been born. The ballistic vector, which until this time was marked with a 'strategic' label, was then 'standardized' and has interested a number of countries in the process of its development. The world has just entered the era of the ballistic proliferation. From the very start of the Eighties, the USA and, to a lesser degree, NATO lead studies and reflections concerned with defense against tactical ballistic missiles within a East West framework. From these studies the ATBM (Anti Tactical Ballistic Missile) made its appearance. In spite of the attempts at control, missile proliferation has accelerated and led, towards the end of the Eighties and the beginning of the Nineties, to the awakening of a new risk known as proliferating. The 1991 Gulf War was accelerated in this manner. This conflict also clarified the fact that the ballistic weapon constituted a formidable means of pressure for countries which had it, in spite of the PATRIOT, which demonstrated the feasibility of an active defense

against ballistic missiles, in spite of their limited performances. This present presentation proposes an overall analysis of the ballistic risk and the possible threat which could result from it and examines the means available for protection against this risk by looking further into all the defensive means. This will constitute the main part of the speech. Lastly, we will endeavor to evaluate the difficulties faced by the architects of the DAMB.
CASI
Antimissile Defense; Architecture; Ballistic Missiles; Defense Program; Europe; Risk; Technology Assessment; Technology Utilization

19950025705 MATRA Defense Espace, Velizy-Villacoublay, France
POSSIBLE ALLIED BALLISTIC MISSILE DEFENSE SYSTEMS: RELATED GUIDANCE AND CONTROL REQUIREMENTS
Roche, C., MATRA Defense Espace, France; Cotillard, C., MATRA Defense Espace, France; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 5 p; In English; See also 19950025702; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

This document discusses several different types of Ballistic Missile Defense Systems for NATO for both medium and long range attacks. The feasibility, technological assessment and forecasting, and defense architecture is presented, along with each system's capabilities.
CASI
Ballistic Missiles; Computer Systems Design; Feasibility Analysis; Missile Defense; Technology Assessment; Warfare

19950025706 GIE Cosyde, Velizy-Villacoublay, France
SOSIE: A PRAGMATIC APPROACH TO THE SIMULATION OF BROAD AIR DEFENSE APPLIED TO THE THEATER LEVEL
SOSIE: UNE APPROCHE PRAGMATIQUE DE LA SIMULATION EN DEFENSE AERIENNE ELARGIE APPLIQUEE AU NIVEAU DU THEATRE
Tanter, A., GIE Cosyde, France; Deas, M., GIE Cosyde, France; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 8 p; In French; See also 19950025702; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The SOSIE concept rests on an approach consisting of using existing simulation models of various systems and subsystems and automatically integrating them with minimum modifications within a center of simulation. The defense simulation against ballistic missiles on the theater level calls upon three levels of simulation: DIAMS; TACSIT, and SPOOK. DIAMS presents a fine level system simulation of weapon ground-to-air average carry, TACSIT presents a level of site defense (base air for example), and SPOOK deals with the theater level itself. SOSIE enables users to use the same detailed simulators, developed by an originator of weapon systems or information and communications, without having to know in detail the models of the simulation. Envisioned in the future is the integration of other models of simulations relating to the air-to-air combat, in particular, the networks of command, controls and communications.
CASI
Air Defense; Ballistic Missiles; Combat; Computer Systems Design; Computerized Simulation; Simulators; Weapon Systems

19950025710 Department of the Air Force, Washington, DC, United States
ACQUISITION, TRACKING, POINTING AND FIRE CONTROL FOR BALLISTIC MISSILE DEFENSE
Humpherys, Thomas W., Department of the Air Force, USA; Gurski, Gary, GRC, USA; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 10 p; In English; See also 19950025702; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The benefits of the ATP (Acquisition Tracking and Pointing) assets to TMD (Theater Missile Defense) are that the platform provides high resolution standoff sensors at low cost and can provide sub micro radian tracking and imaging of dynamic targets, active and passive multispectral data and non-cooperative fire control algorithms. The platform is relatively low cost and can be flown from 4-6 times a year for either sensor performance or phenomenology data collection. The process for collecting and certifying the data are in place and available today. During the past decade we have made significant advances in ATP-FC technologies for ballistic missile defense. The current BMDO ATP assets in general and the HABE testbed in particular can be a key asset in developing TMD weapon systems by providing a means to collect key phenomenology data, test sensor and guidance components, or view and collect data to score test or exercises.
Derived from text
Ballistic Missiles; Data Acquisition; Fire Control; Missile Defense; Missile Tracking; Pointing Control Systems; Remote Sensors; Target Acquisition; Targets; Weapon Systems

19950025711 Phillips Lab., Kirtland AFB, NM, United States
THE HIGH ALTITUDE BALLOON EXPERIMENT DEMONSTRATION OF ACQUISITION, TRACKING, AND POINTING TECHNOLOGIES (HABE-ATP)
Dimiduk, D., Phillips Lab., USA; Caylor, M., Phillips Lab., USA; Williamson, D., Phillips Lab., USA; Larson, L., Phillips Lab., USA; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 11 p; In English; See also 19950025702; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The High Altitude Balloon Experiment demonstration of Acquisition, Tracking, and Pointing (HABE-ATP) is a system built around balloon-borne payload which is carried to a nominal 26-km altitude. The goal is laser tracking thrusting theater and strategic missiles, and then pointing a surrogate laser weapon beam, with performance levels end a timeline traceable to operational laser weapon system requirements. This goal leads to an experiment system design which combines hardware from many technology areas: an optical telescope and IR sensors; an advanced angular inertial reference; a flexible multi-level of actuation digital control system; digital tracking processors which incorporate real-time image analysis and a pulsed, diode-pumped solid state tracking laser. The system components have been selected to meet the overall experiment goals of tracking unmodified boosters at 50- 200 km range. The ATP system on HABE must stabilize and control a relative line of sight between the platform and the unmodified target booster to a 1 microrad accuracy. The angular pointing reference system supports both open loop and closed loop track modes; GPS provides absolute position reference. The control system which positions the line of sight for the ATP system must sequence through accepting a state vector handoff, closed-loop passive IR acquisition, passive IR intermediate fine track, active fine track, and then finally aimpoint determination and maintenance modes. Line of sight stabilization to fine accuracy levels is accomplished by actuating wide bandwidth fast steering mirrors (FSM's). These control loops off-load large-amplitude errors to the outer gimbal in order to remain within the limited angular throw of the FSM's. The SWIR acquisition and MWIR intermediate fine track sensors (both PtSi focal planes) image the signature of the rocket plume. After Hard Body Handover (HBHO), active fine tracking is conducted with a visible focal plane viewing the laser-illuminated target rocket body. The track and fire control performance must be developed to the point that an aimpoint can be selected, maintained, and then track performance scored with a low-power 'surrogate' weapon beam. Extensive instrumentation monitors not only the optical sensors and the video data, but all aspects of each of the experiment subsystems such as the control system, the experiment flight vehicle, and the tracker. Because the system is balloon-borne and recoverable, it is expected to fly many times during its development program.
Derived from text
Digital Systems; High Altitude Balloons; Infrared Detectors; Laser Weapons; Missile Tracking; Optical Tracking; Payloads; Pointing Control Systems; Solid State Lasers; Target Acquisition; Telescopes; Weapon Systems

19950025712 British Aerospace Defence Ltd., Preston, United Kingdom
INTEGRATION ISSUES IN MODULAR MISSION MANAGEMENT AID DEVELOPMENT
Watkins, F. M., British Aerospace Defence Ltd., UK; Noonan, C. A., British Aerospace Defence Ltd., UK; Roberts, K., British Aerospace Defence Ltd., UK; Upton, N. K., British Aerospace Defence Ltd., UK; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 10 p; In English; See also 19950025702; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Mission Management Aid (MMA) program at British Aerospace Defence includes research in the areas of Sensor Data Fusion, Sensor Management, Tactical Situation Assessment and Tactical

Decision Aids. Each project has developed and continues to refine workstation prototypes. As the technology in these prototypes matures it is used to update and improve an integrated MMA system prototype. This paper is concerned with the integration process and the issues surrounding it. The factors which influenced progress during integration include the use of compatible development platforms and programming languages for the prototypes, and the choice of a host architecture which allows a flexible approach to the MMA architecture. The benefits gained from the integration framework include the ability to develop integrated displays and controls, to evaluate performance and effectiveness metrics, and to investigate the boundaries and interactions between the subsystems.
Derived from text
Architecture (Computers); Computer Systems Design; Control Systems Design; Display Devices; Mission Planning; Multisensor Fusion; Programming Languages; UK; Workstations

19950025744 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
ENVIRONMENTALLY SAFE AND EFFECTIVE PROCESSES FOR PAINT REMOVAL ***PROCEDES EFFICACES ET ECOLOGIQUES POUR L'ENLEVEMENT DES PEINTURES***
Apr 1, 1995; 91p; In English; See also 19950025745 through 19950025760
Report No.(s): AGARD-LS-201; ISBN 92-836-1017-2; Copyright Waived; Avail: CASI; A05, Hardcopy; A01, Microfiche

Paint stripping and repainting of aircraft surfaces are required periodically during the operating lifetime of an aircraft. Historically, paint removal has been achieved using chemical strippers, involving materials which contain toxic components and which create hazardous working conditions. The process generates large amounts of hazardous waste from the chemicals used. Alternative methods for aircraft paint removal are now being investigated within the NATO nations with regard to their environmental safety and effective application. These processes include: Plastic Media Blasting, Wheat Starch Dry Media Blasting, Carbon Dioxide Pellet Blasting, Sodium Bicarbonate Blasting and Thermal Decomposition Methods (Laser, Flash Lamps/Carbon Dioxide). The Lecture Series will review these current state-of-the-art alternative methods with environmental effects and related health hazards, costs, process controls, and more.
Aircraft Maintenance; Cleaning; Conferences; Environment Effects; Hazards; Paints; Removal; Toxicity

19950025745 Esquimalt Defence Research Detachment, Victoria British Columbia, Canada
OVERVIEW OF PAINT REMOVAL METHODS
Foster, Terry, Esquimalt Defence Research Detachment, Canada; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 7 p; In English; See also 19950025744; Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

With the introduction of strict environmental regulations governing the use and disposal of methylene chloride and phenols, major components of chemical paint strippers, there have been many new environmentally safe and effective methods of paint removal developed. The new methods developed for removing coatings from aircraft and aircraft components include: mechanical methods using abrasive media such as plastic, wheat starch, walnut shells, ice and dry ice, environmentally safe chemical strippers and paint softeners, and optical methods such as lasers and flash lamps. Each method has its advantages and disadvantages, and some have unique applications. For example, mechanical and abrasive methods can damage sensitive surfaces such as composite materials and strict control of blast parameters and conditions are required. Optical methods can be slow, leaving paint residues, and chemical methods may not remove all of the coating or require special coating formulations to be effective. As an introduction to environmentally safe and effective methods of paint removal, this paper is an overview of the various methods available. The purpose of this overview is to introduce the various paint removal methods available.
Derived from text
Abrasives; Environment Protection; Paints; Removal; Residues

19950025746 Aerospatiale, Direction des Estudes., Toulouse, France
PAINT REMOVAL PRINCIPLES
Malavallon, Olivier, Aerospatiale, France; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 4 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

An attempt is made to group the various processes of paint removal into families. The classifications are distinguished by chemical, mechanical, and thermal phenomena. For each of these phenomena, it is possible to identify the main mechanisms brought into play in material removal leading to paint stripping. The chemical strippers used are methylene chloride, phenolic compounds, and activated acids or activated bases free from phenols, chromates or methylene chloride. However, the methylene chloride and phenolic compounds are being replaced by a new generation of chemical strippers which are less active and their solvent power is lower. to improve the chemical kinetics, 'active' elements are introduced into the composition of these products. Mechanical stripping includes technologies using mechanical phenomena based on erosion, achieved by friction or blasting particles. Thermal stripping, the last classification, makes use of electronics and automation.
CASI
Classifications; Paints; Removal; Stripping

19950025747 Esquimalt Defence Research Detachment, Victoria British Columbia, Canada
BACKGROUND TO PLASTIC MEDIA BLASTING
Foster, Terry, Esquimalt Defence Research Detachment, Canada; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 3 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

Chemical strippers based on active phenolic components in a chlorinated solvent have been the traditional method for removing of paints and coatings from aircraft. With the recent recognition of the environmental and health concerns of chlorinated solvents and the problem disposing of phenols there have been some major developments in paint removal technology. One of the first techniques developed to replace chemical strippers and now one of the most widely used techniques for paint removal from aircraft was plastic media blasting (PMB). The PMB technique is similar to traditional grit blasting (slag, sand alumina or carborundum) techniques used on steel and other metals (based on grits) but using polymer based media that are softer and less aggressive. Plastic media are ranked by hardness and density as well as chemical composition.
Derived from text
Paints; Plastics; Removal; Stripping; Thermosetting Resins

19950025748 Esquimalt Defence Research Detachment, Victoria British Columbia, Canada
DRY MEDIA BLASTING WITH WHEAT STARCH
Foster, Terry, Esquimalt Defence Research Detachment, Canada; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 11 p; In English; See also 19950025744; Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The brand name TECHNOSTRIP covers several types of installations and facilities. These were developed mainly to meet the requirements of customers in the aeronautic field. The range of products includes: complete self-supporting and semi-automated system for aircraft stripping; large-size blasting booth for semi-automatic stripping; manual blasting booth; and sealed and portable manual stripping head. Wheat starch media was developed for particle blasting stripping and is used in TECHNOSTRIP. This paper reviews its origins and use as well as use of automated facilities, reliability, effects on materials, effects on environment, and utilization examples.
Derived from text
Blast Loads; Cleaning; Paints; Removal; Starches; Wheat

19950025749 Esquimalt Defence Research Detachment, Victoria British Columbia, Canada
WATER BLASTING PAINT REMOVAL METHODS
Foster, Terry, Esquimalt Defence Research Detachment, Canada; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 3 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

Water blasting is a paint removal technique that has been used for cleaning and paint removal for many years. The major disadvantages until recently were the slow rate of paint removal and the possibility of damage to the substrate from the high pressures used. With the improvement in nozzle design that allows for higher operating

pressures and the use of environmentally compliant paint softeners or strippers, water blasting is becoming a recognized technique for paint removal in the aircraft industry.
Author
Cleaning; Paints; Removal; Water; Water Treatment

19950025750 Esquimalt Defence Research Detachment, Victoria British Columbia, Canada
PAINT REMOVAL AND SURFACE CLEANING USING ICE PARTICLES
Foster, Terry, Esquimalt Defence Research Detachment, Canada; Visaisouk, S., Ice Blast International Corp., Canada; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 9 p; In English; See also 19950025744; Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Research into the possibility of using ice particles as a blast medium was first initiated at Defence Research Establishment Pacific (DREP) in an effort to develop a more environmentally acceptable paint removal method. A paint removal process was also required that could be used in areas where normal grit blasting could not be used due to the possibility of the residual blasting grit contaminating machinery and other equipment. As a result of this research a commercial ice blasting system was developed by RETECH. This system is now being used to remove paint from substrates that cannot be easily blasted by conventional techniques and also to clean soiled or contaminated surfaces. The problems involved in the development of an ice blast system and its components and their functions are described. Due to the complexity of paint removal using ice blasting, parameters such as air pressure, ice particle size and ice particle flow rate were studied and adjusted to suit the nature of the particular coating and substrate of interest. The mechanism of paint removal by ice particles has also been investigated. A theoretical model has been developed to explain the different paint removal mechanisms such as erosion by abrasion and erosion by fracture as they relate to ice blasting. Finally, the use of ice blasting to removal paint from a variety of substrates is presented as well as examples of surface cleaning and surface decontamination.
Author
Blast Loads; Cleaning; Ice; Paints

19950025751 Aerospatiale, Direction des Estudes., Toulouse, France
STRIPPING WITH DRY ICE
Malavallon, Olivier, Aerospatiale, France; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 2 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

Mechanical-type stripping using dry ice (solid CO2) consists in blasting particles of dry ice onto the painted surface. This surface can be used alone or in duplex according to type of substrate to be treated. According to operating conditions, three physical mechanisms may be involved when blasting dry ice particles onto a paint system: thermal shock, differential thermal contraction, and mechanical shock. The blast nozzle, nozzle travel speed, blast angle, stripping distance, and compressed air pressure and media flow rate influence the stripping quality and the uniformity and efficiency obtained.
Derived from text
Blast Loads; Carbon Dioxide; Ice; Paints; Removal; Solidified Gases

19950025752 Aerospatiale, Direction des Etudes., Toulouse, France
AQUASTRIP
Malavallon, Olivier, Aerospatiale, France; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 3 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

The Aquastrip stripping process is a mechanical process. It consists of applying a high-pressure water jet by means of a rotating stripping head with two water jets. The efficiency of these water jets is improved in certain cases by using a paint softener before applying the water jet process.
Derived from text
Cleaning; Hydraulic Jets; Paints; Removal

19950025754 Aerospatiale, Direction des Estudes., Toulouse, France
SELECTIVE CHEMICAL STRIPPING
Malavallon, Olivier, Aerospatiale, France; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 3 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

At the end of the 80's, some of the large European airlines expressed a wish for paint systems with improved strippability on their aircraft, allowing the possibility to strip down to the primer without altering it, using 'mild' chemical strippers based on methylene chloride. These improvements were initially intended to reduce costs and stripping cycle times while facilitating rapid repainting, and this without the need to change the conventionally used industrial facilities. The level of in-service performance of these paint systems was to be the same as the previous ones. Requirements related to hygiene safety and the environment were added to these initial requirements. to meet customers' expectations, Aerospatiale, within the Airbus Industry GIE, formed a work group. This group was given the task of specifying, following up the elaboration and qualifying the paint systems allowing requirements to be met, in relation with the paint suppliers and the airlines. The analysis made in this report showed the interest of transferring as far upstream as possible (to paint conception level) most of the technical constraints related to stripping. Thus, the concept retained for the paint system, allowing selective chemical stripping, is a 3-coat system with characteristics as near as possible to the previously used paints.
Derived from text
Aircraft Structures; Cleaning; Paints; Removal; Requirements

19950025758 Esquimalt Defence Research Detachment, Victoria British Columbia, Canada
OPERATIONAL PARAMETERS AND MATERIAL EFFECTS
Foster, Terry, Esquimalt Defence Research Detachment, Canada; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 6 p; In English; See also 19950025744; Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Although there are six types of plastic media, the focus on operational parameters and materials effects of PMB (plastic media blasting) will be on the Type 5 acrylic media with some reference and comparisons to Type 2 media. The other four plastic media are not used extensively in general aircraft stripping and will not be discussed in this paper. There are several military and commercial documents available with detailed procedures for plastic media stripping of aircraft. The actual choice of blasting parameters will, to a great extent, depend on the media chosen and the substrate to be stripped. The effects of various blasting conditions on materials can be evaluated using visual, optical microscopy, scanning electron microscopy (SEM) and mechanical and corrosion test methods. In some test methods up to twelve specimens are required to give meaningful results, therefore statistical analysis tools are also required to interpret the results due to the scatter in some of the data.
Derived from text
Acrylic Resins; Blast Loads; Cleaning; Paints; Selection; Stripping; Substrates; Surface Properties; Surface Reactions

19950025759 Aerospatiale, Direction des Etudes., Toulouse, France
PROCESS EVALUATION
Malavallon, Olivier, Aerospatiale, France; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 3 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

It is not always easy to conduct a study and implement a systematic policy in the aeronautical paint stripping field. The situations to be studied are complicated by extensive technical data, material conditions and financial unknowns. to these are added demands both in the civil and military fields to increase the performance obtained, optimize cycles, reduce recurrent costs, quickly amortize investments and now increasing respect for the environment. To reply correctly, the various possibilities must be assessed using, if possible, identical criteria and reference systems. The only criterion which applies to all the processes and methods is the overall stripping cost. It is not sufficient for a process to meet the related technical requirements (for example 'IATA guidelines'), it must also be economically justifiable. The overall costs take into account therefore the costs and materials, labor and also the downtime of the aircraft, amortization and maintenance of the

installations and processing of waste, etc. For many years now, AEROSPATIALE has undertaken research and development programs to find and evaluate alternatives to the conventional chemical stripping process. This work has led it to carry out comparative analyses from technical elements enhanced as the work progressed.
Derived from text
Aircraft Maintenance; Alternatives; Paints; Policies; Removal; Stripping

19950025760 Aerospatiale, Direction des Etudes., Toulouse, France
STANDARDIZATION WORK
Malavallon, Olivier, Aerospatiale, France; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 1 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

For several years now, the main civil aircraft manufacturers (Airbus and its partners, Boeing, Fokker, McDonnell Douglas) have been working jointly on the writing of technical recommendations and the drawing up of an international standard. This work concerns the evaluation of the processes and products used to strip aeronautical paint systems. This procedure was initiated on request from the main airlines. In effect, the airlines are faced with situations in which the financial and operational objectives are becoming increasingly important. The need was felt to rationalize and, if possible, harmonize the criteria and technical requirements of the various civil aircraft manufacturers in order to facilitate in-service maintenance of the fleets of airlines operating Airbus, Boeing, Douglas aircraft, etc.
Derived from text
Aircraft Maintenance; Cleaning; Commercial Aircraft; Paints; Removal; Standardization

19950026705 Advisory Group for Aerospace Research and Development, Guidance and Control Panel, Neuilly-Sur-Seine, France
DUAL USAGE IN MILITARY AND COMMERCIAL TECHNOLOGY IN GUIDANCE AND CONTROL ***TECHNOLOGIES DUALES MILITAIRES ET CIVILES DE GUIDAGE/PILOTAGE***
Mar 1, 1995; 179p; In English; 59th, 20-21 Oct. 1994, Rome, Italy; See also 19950026706 through 19950026724
Report No.(s): AGARD-CP-556; ISBN 92-836-1016-4; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

This volume contains the Technical Evaluation Report and the 19 unclassified papers, presented at the Guidance and Control Panel Symposium held in Pratica di Mare (Rome), Italy, from 20th to 21st October 1994. The papers presented covered the following headings: (1) Dual-use Opportunities and Missions; (2) Navigation Sensors for Dual-use Applications; (3) Multi-sensor Navigation Applied to Dual-uses; (4) Dual-use Technology for Air-Ground Operations; and (5) Dual-use Applications of G&C Technology.
Command and Control; Command Guidance; Conferences; Control Boards; Guidance Sensors; Military Technology; Multisensor Applications; Navigation

19970001701 Virginia Univ., Intelligent Processing of Materials Lab., Charlottesville, VA United States
INTELLIGENT PROCESSING OF SMART MATERIALS
Wadley, Haydn N. G., Virginia Univ., USA; Smart Structures and Materials: Implications for Military Aircraft of New Generation; Oct. 1996; 24p; In English; 41st; Sagamore Conference, USA; Sponsored by Department of the Army, USA; See also 19970001697; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Intelligent Processing of Materials (IPM) is an emerging methodology for simulating and controlling the processing and manufacture of materials. It is finding widespread application during the manufacture of electronic, photonic and composite (i.e. high performance) materials, primary metals such as steel/aluminum and is an enabling technology for smart materials/structures synthesis/processing. IPM simulation tools seek to create, at the level of an engineering workstation, a 'virtual' version of a process. They combine process models for a material's response to processing stimuli (e.g. pressure, temperature, environmental conditions, etc.) with characteristics of the process equipment to predict the material's performance defining attributes at the completion of the process. IPM controllers are an innovative extension of today's state-of-the-art in control technology. They exploit the recent availability of noninvasive sensors that sense critical product variables during the process. This new knowledge about the state of the process, together with the process models, can be used to plan and execute feedback control schemes leading to smart materials with 'goal state' combinations of performance defining property attributes.
Author
Smart Structures; Mechanical Properties; Feedback Control; Shape Memory Alloys

19970016376 Cryogenic, Marine and Materials Consultants, Southampton, United Kingdom
CRYOGENIC ENGINEERING AND MATERIALS
Wigley, David A., Cryogenic, Marine and Materials Consultants, UK; Feb. 1997; 10p; In English; See also 19970016374; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The following aspects of cryogenic engineering and basic properties of materials are considered: (1) The oxygen-nitrogen binary phase diagram and the formation of liquid oxygen in unsealed insulation systems. (2) The large liquid/gas volume expansion and the dangers inherent in the pressure created in closed containers. (3) Nucleate and film boiling in liquid nitrogen, the different heat transfer rates in between solid/liquid and solid/gas, operation of liquid nitrogen level sensors and of electric immersion heaters used to evaporate liquid nitrogen. (4) Safe working practices for handling liquid nitrogen, the physiological effects of oxygen deficiency, anoxia and asphyxiation, the use of oxygen monitors, breathing apparatus, condensation clouds and nitrogen concentration, escape routes and victim rescue. (5) The cause and avoidance of cold burns by good working practice and the use of protective clothing. (6) Storage of liquid nitrogen and its transfer using bare and insulated transfer lines over long and short distances. (7) Selection of materials for their LOX compatibility and for the avoidance of moisture desorption. (8) Thermal contraction of metals and non-metals, problems caused by temperature gradients and the use of materials with mis-matched expansion coefficients. (9) Thermal conductivity and insulation, heat capacity, thermal response times and thermal shock.
Derived from text
Cryogenics; Phase Diagrams; Gas Expansion; Heat Transfer; Safety Management; Protective Clothing; Storage Tanks; Moisture; Thermal Conductivity; Metals

19970019652 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
BOLTED/BONDED JOINTS IN POLYMERIC COMPOSITES ***ASSEMBLAGES BOULONNES/COLLES EN MATERIAUX COMPOSITES POLYMERES***
AGARD Conference Proceeding: Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 272p; In English; 83rd; Structures and Materials Panel, 2-3 Sep. 1996, Florence, Italy; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19970019653 through 19970019676
Report No.(s): AGARD-CP-590; ISBN 92-836-1046-6; Copyright Waived; Avail: CASI; A12, Hardcopy; A03, Microfiche

The objective of this AGARD Specialists' Meeting on Bolted/Bonded Joints in Polymeric Composites was to examine the state of the art in joining polymeric composites, to consider the relative merits of the various methods and to highlight gaps in the technology which should be addressed. The papers presented cover a number of aspects concerning the application of adhesively bonded and mechanically fastened joints in the analysis, design, manufacturing, and repair of fiber-polymer composites. The focus is on aerospace rather than commercial products.
Author
Adhesive Bonding; Fiber Composites; Bonded Joints; Bolted Joints

19970023078 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
ENVIRONMENTALLY COMPLIANT SURFACE TREATMENTS OF MATERIALS FOR AEROSPACE APPLICATIONS ***LES TECHNIQUES DE TRAITEMENT DE SURFACE CONFORMES A LA REGLEMENTATION SUR LA PROTECTION DE L'ENVIRONNEMENT POUR LES MATERIAUX DESTINES AUX APPLICATIONS AEROSPATIALES***
Environmentally Compliant Surface Treatments of Materials for Aerospace Applications; Feb. 1997; 180p; In English; In French; 83rd; Structures and Materials Panel, 4-5 1996, Florence, Italy; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19970023079 through 19970023095

Report No.(s): AGARD-R-816; ISBN 92-836-0040-1; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

In recent years, a great deal of important materials and process R&D has resulted in new or modified aerospace materials that are more environmentally benign. These new materials are implemented on a limited basis, however, wide spectrum materials substitutions are rare because many of the new materials have characteristics that may not fully meet traditional performance standards. Also, as is the case with the phosphoric sulfuric acid anodize process as a substitute for the chromic acid anodize, some processes are less controllable or robust and therefore may suffer when production scale-up of laboratory developed technology is attempted. While low volatile organic compounds (VOC), water-reduced and non-chromate inhibited organic coating technology is developed and being optimized, inorganic finishing and electroplating technology is still immature and many different technologies are under evaluation. Widely implementable materials and process substitutes for electroplated cadmium and chromium are not currently available and therefore require continued investment in research and development.
Derived from text

Metal Surfaces; Environment Protection; Surface Finishing; Cleaning; Protective Coatings; Aerospace Industry; Primers (Coatings); Research

19970023086 Anteon Corp., Dayton, OH United States
ENVIRONMENTALLY FRIENDLY CLEANING PROCESSES FOR METAL SURFACES
Hauwiller, P. B., Anteon Corp., USA; Feb. 1997; 10p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Environmental laws, regulations and policies require that traditional cleaners (1,1,1 trichloroethane, Methyl Ethyl Ketone and CFC113) be eliminated from current and future cleaning operations. In order to achieve this goal the Air Force has determined that pollution prevention is the preferred approach. Aqueous cleaning has been the predominant replacement cleaning technology to reduce or eliminate hazardous cleaning waste. However, this tends to shift the waste stream from air to water. The USA Air Force, Wright Laboratory decided to investigate minimal waste cleaning technologies for prebonding and precision cleaning processes. Four technologies are being developed to meet the needs of DOD depots, namely, Supercritical CO2 Convection Flow cleaning, Low-Temperature Oxygen Plasma cleaning, Laser Cleaning and CO2/UV light cleaning. Each of these technologies produces no more waste than the contaminant they are removing. Supercritical CO2 Convection Flow cleaning is much simpler and more flexible than traditional supercritical CO2 cleaning processes, avoiding high pressure pumps which tend to increase cost, complexity and cycle-time. Low-temperature oxygen plasma cleaning breaks down hydrocarbon contamination in oxygen tubing resulting in benign cleaning residue which is entrained in the vacuum flow and removed from the tube. Laser cleaning utilizes laser energy to remove tightly bound contaminants and coatings. The CO2/UV light cleaning system has demonstrated its cleaning effectiveness for a large number of shop soils. Surfaces cleaned with this method exhibit excellent bondability.
Author

Environment Protection; Cleaning; Metal Surfaces; Cleaners

19970023088 Deutsche Airbus G.m.b.H., Bremen, Germany
PHOSPHORIC SULFURIC ACID ANODIZING (PSA): A HEAVY METAL FREE ALTERNATIVE FOR HIGH QUALITY SURFACE PRETREATMENT OF ALUMINIUM
Matz, C. W., Deutsche Airbus G.m.b.H., Germany; Hilling, B., Deutsche Airbus G.m.b.H., Germany; Kelm, W., Deutsche Airbus G.m.b.H., Germany; Kock, E., Deutsche Airbus G.m.b.H., Germany; Environmentally Compliant Surface Treatments of Materials for Aerospace Applications; Feb. 1997; 12p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Chromic Acid Anodizing (CAA) is often applied in the European aircraft industry for pretreatment of aluminum substrates before coating for corrosion protection and before structural adhesive bonding. by this usage, the quality requirements for any alternative process is set with respect to adhesion performance, corrosion protection and fatigue properties, including the compatibility to proven processes and materials. At DASA, the Phosphoric Sulfuric Acid Anodizing process (PSA) was elaborated and verified from laboratory scale up to industrial shop trials. Results reaching from characterizing the oxide morphology by electron microscopy to quality assurance tests on full scale parts are presented.
Author

Phosphoric Acid; Sulfuric Acid; Anodizing; Pretreatment; Aluminum; Environment Protection; Metal Surfaces

19970023089 Army Research Lab., Metals Research Branch, Aberdeen Proving Ground, MD United States
ENVIRONMENTALLY BENIGN ION BEAM SURFACE TREATMENTS
Demaree, J. Derek, Army Research Lab., USA; Hirvonen, James K., Army Research Lab., USA; Fountzoulas, Costas G., Army Research Lab., USA; Feb. 1997; 10p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Selected usage of environmentally benign ion beam processes. namely ion implantation and ion beam assisted deposition (IBAD), are discussed in terms of their technical merits, their current status, and the various factors governing their acceptance within the U.S. Department of Defense (DoD) user community.
Author

Surface Treatment; Ion Beams; Environment Protection; Ion Implantation

19970023090 Bombardier, Inc., Dorval, Quebec Canada
EVALUATION OF AQUEOUS DEGREASING AS REPLACEMENT FOR VAPOUR DEGREASING WITH 1,1,1-TRICHLOROETHANE AT BOMBARDIER-CANADAIR
Alcorta, Hector, Bombardier, Inc., Canada; Menard, Daniel, Bombardier, Inc., Canada; Lizee, R., Bombardier, Inc., Canada; Environmentally Compliant Surface Treatments of Materials for Aerospace Applications; Feb. 1997; 10p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Back in 1990, in view of the environmental regulations in the U.S., and supporting Canada's commitment to the Montreal Protocol, Bombardier-Canadair started investigating the feasibility of using aqueous degreasing to replace vapor degreasing with 1,1,1-trichloroethane (TCA). This paper presents the results of Canadair's laboratory-scale and pilot line evaluations. Because of the large variety of parts sizes and shapes produced at Canadair, it was decided to evaluate aqueous degreasing by immersion with mechanical agitation or solution recirculation. Seven candidate aqueous degreasers were selected for evaluation based on data obtained from several airframe and aircraft manufacturers who had already evaluated many products. The twelve contaminants most commonly found on parts going through the vapor degreasers at the time of the study were identified and used for the evaluation. Both TCA and an alkaline cleaner already in use at Canadair were used as controls. From the seven aqueous degreasers evaluated, only three met all the criteria. Laboratory results indicated that, when used as specified, these three degreasers did an acceptable job of removing the contaminants. Therefore, these cleaners were considered acceptable to be used in an immersion process at Canadair as substitutes for vapor degreasing with TCA, and were recommended for pilot line evaluation. One of the three candidates was tested in a pilot line and then successfully implemented into production.
Author

Submerging; Aqueous Solutions; Cleaners; Environment Protection

19970023091 National Aerospace Lab., Emmeloord, Netherlands
CADMIUM SUBSTITUTION ON AIRCRAFT
Vaessen, G., National Aerospace Lab., Netherlands; Andrews, F., Short Bros. and Harland Ltd., UK; Brindle, C., British Aerospace Public Ltd. Co., UK; Hultgren, E., Saab-Space A.B., Sweden; Kock, E., Deutsche Aerospace A.G., Germany; Marchandise, D., Aerospatiale, France; tHart, W., National Aerospace Lab., Netherlands; Smith, C. J. E., Defence Research Agency, UK; Feb. 1997; 6p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

A Garteur (Group for Aeronautical Research and Technology in Europe) collaborative program of research being undertaken to evaluate alternatives to cadmium plating for the corrosion protection of high strength steel aerospace components and fasteners is described. Coatings being investigated include electrodeposited zinc-nickel and zinc cobalt-iron, ion vapor deposited and electrodeposited aluminum,

metallic-ceramic deposits containing zinc and aluminum flakes and magnetron sputtered aluminum magnesium coatings. The program is examining both the corrosion resistance of the coatings and their galvanic compatibility with aluminum alloy airframe materials. The effects of coatings on fatigue life and susceptibility to hydrogen embrittlement are being determined. Physical properties including conductivity and lubricity are being studied, microstructure and resistance to aircraft fluids. The program involves research in seven laboratories from the aerospace research institutes and the aircraft industry based in France, Germany, The Netherlands, Sweden and the United Kingdom.
Author
Corrosion Prevention; Protective Coatings; Electrodeposition; Magnetron Sputtering; Microstructure; Corrosion Resistance; Airframe Materials; Aluminum Alloys; Research; Vapor Deposition; High Strength Steels

19970023092 Wright Lab., Systems Support Div., Wright-Patterson AFB, OH United States
R&D TO DEVELOP SUBSTITUTES FOR ELECTROPLATED HARD CHROME
Reinhart, Theodore J., Wright Lab., USA; Feb. 1997; 5p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Hexavalent chromium (CR(+6)) is the ionic species used in the traditional electroplating of chromium for corrosion and wear resistance, referred to as electrolytic hard chromium (EHC). The resulting coating provides not only a hard wear resistive barrier, but also has lubricity making it ideal for hydraulic applications. Typical applications include landing gear components, flight control actuators, gun barrels, and turbine engine components. EHC plating is used for both rebuilding worn parts and as a protective coating by original equipment manufacturers. The U.S. Environmental Protection Agency (EPA) has determined hexavalent chromium to be detrimental to health and the environment. Hexavalent chrome is known carcinogen, with some studies indicating a fifteen fold increase in instances of lung cancer among workers exposed to chrome plating operations. This substance is on the EPA list of 17 toxic compounds and is in the 33/55 program for reduction of hazardous materials. In January 1995, the EPA released new Clean Air Act rules to limit emissions from EHC operations. As a result, the Occupational Safety and Health Administration (OSHA) is proposing to decrease the exposure limit from .1 mg/m(exp 3) to .005 mg/m(exp 3). Reducing emissions to this new level will greatly increase the operating cost of EHC plating. This has led to investigation of several alternative coatings and coating processes.
Derived from text
Environment Protection; Protective Coatings; Research and Development

19970023095 Naval Aviation Depot, Cherry Point, NC United States
ENVIRONMENTALLY COMPLIANT ELECTROPLATING ALTERNATIVES
Roberts, Mark, Naval Aviation Depot, USA; Feb. 1997; 7p; In English; See also 19970023078; "Sponsored in part by the H-46 and SERDP Program Office."; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The use of cadmium and chromium as electroplating metals continues to come under criticism from several directions. Both materials have been targeted by the USEPA for reduction/elimination. The toxicity of specific forms of both metals is widely known and efforts are underway to identify workable alternatives for both materials. This paper presents the methodology and results of tests performed to identify performance properties of select cadmium and chromium substitutes. These results and their interpretation are not to be inferred to be official US Navy policy.
Author
Environment Protection; Tensile Tests; Fatigue Tests; Protective Coatings

19980206002 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
ADVANCED NON-INTRUSIVE INSTRUMENTATION FOR PROPULSION ENGINES *L'INSTRUMENTATION NON-INVASIVE AVANCEE POUR LES PROPULSEURS*
Advanced Non-Intrusive Instrumentation for Propulsion Engines; May 1998; 550p; In English; In French; See also 19980206003 through 19980206050; Original contains color illustrations
Report No.(s): AGARD-CP-598; AD-A348957; ISBN 92-836-0055-X; Copyright Waived; Avail: CASI; A23, Hardcopy; A04, Microfiche

Changes in engine technology such as higher temperatures, higher tip speeds, new metal/composite/ceramic materials together with radical changes in design philosophy will require amongst other prerequisites the ability to measure and to monitor key internal gas and structural characteristics. The symposium papers presented non-intrusive measurement and analysis technologies in the following categories: Laser Point Measurements (11); Absorption and Infrared Techniques (4); Paints - Surface Sensors (6); Laser Induced Fluorescence (6); Mechanical (7); Films (5); Laser Planar Measurement (9); and a Keynote Address
Author
Nonintrusive Measurement; Propulsion; Engine Parts; Gas Turbine Engines; Optical Measurement; Laser Applications; Combustion

19990007863 Wright Lab., Armament Directorate, Eglin AFB, FL United States
SMALL EFFECTIVE AIR-TO-SURFACE MUNITIONS FOR UNMANNED TACTICAL AIRCRAFT APPLICATIONS
Brubaker, D. R., Wright Lab., USA; Jul. 1998; 12p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes two emerging munition technologies beneficial to Unmanned Tactical Aircraft (UTA) and attempts to define a necessary weapon load capability. to determine a weapon/loadout combination that maximized the lethal effectiveness of an UTA while minimizing the payload weight required, a mission level analysis was conducted and concludes that a minimum of 1000-lb (454 kg) of payload provides an UTA a viable air-to-ground combat mission capability. A 2000-lb (908 kg) payload provides an increased effectiveness but must be contrasted with the associated increase in UTA cost, size, weight and propulsion needed to employ the additional payload weight.
Author
Pilotless Aircraft; Weapons Delivery; Payload Integration; Air to Surface Missiles; Combat

19990014379 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
LOW COST MANUFACTURING
Johnson, Verner J., Advisory Group for Aerospace Research and Development, France; Holzwarth, Richard C., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 121-125; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Several specific technologies relating to design approaches, design concepts, and manufacturing processes are being developed now that will lead to more integrated structure for future airframes. Unitised aircraft structures will be combinations of advanced composite and metallic structures that allow for designs with reduced numbers of fabricated parts and assembly steps. Material selection will be made on the basis of load condition and intensity, temperature range, specific strength, specific cost, or critical factors based on structural application. Low cost manufacturing will be influenced primarily by design, with no single material system or manufacturing process being the preferred path. Design concepts that emphasize more unitized structure are synergistic with manufacturing processes that emphasize fabrication of articles that are virtually the finished

product. Systems integration issues are major players to achieving low cost manufacturing, and new approaches to design and manufacturing of these subsystems are critical.
Derived from text
Low Cost; Manufacturing; Systems Integration; Aircraft Structures; Aircraft Production Costs

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COMMUNICATIONS AND RADAR

19950025707 Ballistic Missile Defense Organization, Advanced Capabilities Div., Washington, DC, United States
TMD DETECTION AND TRACKING USING IMPROVED AWACS SENSORS
Petersen, Steve, Ballistic Missile Defense Organization, USA; Kinashi, Yasuhiro, Nichols Research Corp., USA; Leslie, Daniel, Schafer, W. J. Associates, Inc., USA; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 10 p; In English; See also 19950025702; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper identifies an UOES (User Operational Evaluation Systems) version of an airborne surveillance sensor funded by the BMDO (Ballistic Missile Defense Organization). The sensors will be integrated into an operational AWACS E-3 upgrade program. This BMDO program initiative is called Extended Airborne Global Launch Evaluator, or EAGLE. Initial Operational Capability (IOC) of the EAGLE system will be ready in time to support the THAAD/GBR UOES capability. This airborne system, when developed, will consist of a passive infrared surveillance sensor (IRSS) with an active laser-ranger, on board an upgraded AWACS E3 aircraft to operate effectively in the TMD (theater missile defense) mission. The objective for the EAGLE is to field, in a reasonably short time and at a relatively low cost, a cueing sensor capability in regional conflicts to augment the existing space-based surveillance systems. With autonomous surveillance capability to search a wide-sector field, the EAGLE can detect and track boosting TBM's shortly after launch or as they break the clouds. Its passive IR sensor can also detect and track warm hardbody targets. Together with its laser-ranger, it is able to determine, immediately after the booster burn-out, very precise target state vectors that are accurate enough to predict their eventual impact points, to cue fire control radars, and to engage the weapons, if needed. Its primary TMD mission is to provide precise cueing of fire control radars to initiate the active defense weapon systems. Accurate cues from the EAGLE will off load radar resources to enable earlier detection of the targets at longer extended ranges, thereby increasing the interceptor battlespace for potentially more effective defense engagements and opportunities. It can also provide a precise early warning message to enable immediate TBM attack assessment and appropriate selection of defense engagement options by the battle manager. The functions of the sensor suite can be distributed, such that it can be tasked independently to observe the threat intercept, while providing continuous surveillance of new TBM launches, to support the kill assessment function for shoot-look-shoot opportunities. Another potential function that can be performed by the EAGLE is the estimation of TMD launch points (LPE) for counterforce support. This technical paper provides an expanded discussion of the EAGLE's mission roles, specific system functions, and its detection and tracking performance capability. The paper also addresses the sensor and the laser subsystem design characteristics and operational modes required to accomplish all its functions. Initial analyses indicate that the impact of scattering and absorption of the IR signatures and laser signals will be minimal on the performance of the system. Recent satellite data provides measurement of atmospheric extinction. Propagation statistics, based on satellite observations are presented for global regions of interest to TMD.
Derived from text
Applications Programs (Computers); Ballistic Missiles; Infrared Detectors; Laser Applications; Laser Ranger/Tracker; Missile Defense; Missile Detection; Missile Tracking; Remote Sensors; Surveillance; Weapon Systems

19950025714 Raytheon Canada Ltd., Waterloo Ontario, Canada
MULTISENSOR DATA FUSION FOR INTEGRATED MARITIME SURVEILLANCE
Premji, A., Raytheon Canada Ltd., Canada; Ponsford, A. M., Raytheon Canada Ltd., Canada; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 12 p; In English; See also 19950025702; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

A prototype Integrated Coastal Surveillance system has been developed on Canada's East Coast to provide effective surveillance out to and beyond the 200 nautical mile Exclusive Economic Zone. The system has been designed to protect Canada's natural resources, and to monitor and control the coastline for smuggling, drug trafficking, and similar illegal activity. This paper describes the Multiple Sensor - Multiple Target data fusion system that has been developed. The fusion processor has been developed around the celebrated Multiple Hypothesis Tracking algorithm which accommodates multiple targets, new targets, false alarms, and missed detections. This processor performs four major functions: plot-to-track association to form individual radar tracks; fusion of radar tracks with secondary sensor reports; track identification and tagging using secondary reports; and track level fusion to form common tracks. Radar data from coherent and non-coherent radars has been used to evaluate the performance of the processor. This paper presents preliminary results.
Derived from text
Airborne Surveillance Radar; Coherent Radar; Marine Environments; Multisensor Fusion; Radar Data; Radar Targets; Remote Sensing; Remote Sensors; Surveillance

19950025715 Waterloo Univ. Ontario, Dept. of System Design.; **Canada**
MULTIPLE TARGET TRACKING BASED ON CONSTELLATION MATCHING AND KALMAN FILTER
Wong, Andrew K. C., Waterloo Univ. Ontario, Canada; Leung, Henry, Defence Research Establishment Ottawa, Canada; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 22 p; In English; See also 19950025702; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

A new approach to multiple target tracking (MTT) problem is developed. The data association (DA) problem is solved by an attributed subgraph isomorphism approach called constellation matching (CM). The CM method exploits, in the most direct way, the spatial configuration of the collection of targets which are subject to temporal and spatial constraints. The CM-based tracking system combines the CM technique with the Kalman filter to track and confirm the trajectories of multiple targets. The efficiency of this new approach is demonstrated using real-life multiple target radar tracking data and the results are compared to those obtained by a multiple hypothesis tracking (MHT) system.
Author
Constellations; Kalman Filters; Matching; Multiple Target Tracking; Radar Targets; Radar Tracking; Tracking Problem; Trajectories

19950025719 Department of the Air Force, Eglin AFB, FL, United States
ELECTRONIC COMBAT AND LETHAL DEFENSE SUPPRESSION
Rose, Leo. J., Department of the Air Force, USA; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 3 p; In English; See also 19950025702; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Air forces across the world strive to protect their valuable resources from both the air and ground threats. Over the past few years, the surface-to-air missile threat has become more sophisticated and more deadly. It is far cheaper and less technical for a country to own and operate a ground missile system than to maintain a credible air force. It is for this reason that the attention to the ground threat has grown over the past few years. This paper discusses the approach the U.S. Air Force has taken in protecting its aircraft from these ground

threats and how the mission of Lethal Defense Suppression has evolved into the complimentary tasks of Reactive Suppression and Pre-emptive Destruction.
Derived from text
Air Defense; Combat; Electronic Countermeasures; Electronic Warfare; Missile Systems; Mission Planning; Surface to Air Missiles; Technology Assessment; USA

19950025720 Ballistic Missile Defense Organization, Washington, DC, United States
USING A RED TEAM TO DEVISE COUNTERMEASURES
Swedenburg, R. L., Ballistic Missile Defense Organization, USA; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 12 p; In English; See also 19950025702; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The ability of a defense system to operate effectively when deployed in battle is dependent on designs able to deal with countermeasures against the defense. The formation of a technical Red Team to stress the preliminary designs of the defensive system with technologically feasible and effective potential countermeasures provides a means to identify such potential countermeasures. This paper describes the experience of the U.S. Ballistic Missile Defense Organization's (BMDO) Theater Missile Defense Red Team since the Gulf War in 1991, the Red-Blue Exchange process, and the value it has provided to the designers of the U.S. Theater Missile Defense systems for developing robust systems. A wide-range of technologically feasible countermeasures has been devised, analyzed, tested for feasibility, and provided to the system developers for mitigation design. The process for independently analyzing possible susceptibilities of preliminary designs and exploiting the susceptibilities to identify possible countermeasures is explained. Designing and characterizing the Red Team's countermeasures, determining their feasibility, and analyzing their potential effectiveness against the defense are explained. A technique for the Blue Team's designers to deal with a wide range of potential countermeasures is explained.
Derived from text
Ballistic Missiles; Control Systems Design; Electronic Control; Electronic Countermeasures; Electronic Warfare; Knowledge Based Systems; Mathematical Models; Missile Defense; Systems Engineering; Warfare

19950026070 Elmer, Rome, Italy
HELICOPTER HF COMMUNICATIONS USING THE NVIS MODE
Proia, M., Elmer, Italy; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 12 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The importance of helicopters in the battlefield scenarios is significantly increasing as the new weaponry and guidance control systems allow use of helicopters in a multiplicity of roles, ranging from anti-tank operations to rapid transportation of men and materials. Missions are often assigned to the helicopters that require flying at close distance from the enemy positions. In these cases, low-altitude flying is necessary for survivability and this type of operation, designated as Nap-Of-Earth (NOE) flying, is a well established helicopter tactic for concealment against enemy fire. In the ordinary modes of operation, radio communications between the helicopter and other platforms in the tactical area are supported by the VHF1 (30 to 88 MHz), VHF2 (108 to 172 MHz)m, and UHF (225 to 400 MHz) frequency bands over line-of-sight (LOS) links. The VHF1 band is used by the helicopter to communicate with ground forces during RECCE missions and to interact with other battlefield units for mission management and briefing. The VHF2 band is dedicated to communications with the Base for ATC purposes, while the UHF band is universally used for Ground-Air-Ground and Air-to-Air links in Air Defense operations. As NOE altitudes for helicopters are typically in the order of a few feet, LOS conditions are seldom achieved due to interposed obstacles (such as vegetation or a hilly landscape) or simply because at NOE altitudes the distance between the communicators may well exceed the LOS range. In this scenario precluding effective use of tactical VHF, helicopter to ground and helicopter to helicopter links can be reliably established over battlefield distances by use of the HF propagation mode known as Near-Vertical - Incidence-Skywave (NVIS), whereby an RF signal with a high angle of incidence (greater than 80 degrees) is reflected by the ionosphere back to earth producing an umbrella-type coverage. By appropriate selection of the operating frequency in 1 to 2 MHz passbands (windows) located in the 2 to 10 MHz range, NVIS provides gapless coverage over distances up to 300 km.
Derived from text
Air Defense; Airborne Equipment; Helicopters; Low Altitude; Propagation Modes; Radio Communication; Tactics; Ultrahigh Frequencies; Very High Frequencies; Weapon Systems

19950026071 Army Communications-Electronics Command, Space and Terrestrial Communications Directorate., Fort Monmouth, NJ, United States
TACTICAL LOW-LEVEL HELICOPTER COMMUNICATIONS
Ricciardi, Bernard V., Army Communications-Electronics Command, USA; Hagn, George H., SRI International Corp., USA; August, Gerald, SRI International Corp., USA; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 13 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper identifies a systems approach to communications requirements, defines a helicopter communications system model, and describes some potential paths for future investigation and development to improve helicopter communications. The primary focus is on external communications to other helicopters and to ground stations.
Derived from text
Helicopters; Low Altitude; Mathematical Models; Multipath Transmission; Pulse Communication; Radio Communication; Radio Frequencies; Tactics; Voice Communication

19950026080 Defence Research Agency, Bedford, United Kingdom
THE ANGLO-FRENCH COMPACT LASER RADAR DEMONSTRATOR PROGRAMME
Hogg, G. M., Defence Research Agency, UK; Harrison, K., Defence Research Agency, UK; Minisclou, S., STTE, France; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 8 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

CLARA is an Anglo-French Compact Laser Radar technical demonstrator program. It is a multi-mode CO2 laser radar, the primary mode being cable and obstacle warning, with additional modes including terrain following and a range of targeting modes. The 3 1/2 year program will provide both France and the UK with a podded equipment in 1996. The UK will carry out fixed wing trials and France will fit their pod on a helicopter. The flight trials data are being exchanged between the two countries.
Derived from text
Aerodynamic Configurations; Air Navigation; Carbon Dioxide Lasers; Helicopters; Multispectral Radar; Optical Radar; Radar Targets; Research Projects

19950026716 Eurocopter Deutschland G.m.b.H., Munich, Germany
HELIRADAR: A ROTATING ANTENNA SYNTHETIC APERTURE RADAR FOR HELICOPTER ALLWEATHER OPERATIONS
Kreitmair-Steck, W., Eurocopter Deutschland G.m.b.H., Germany; Wolframm, A. P., Deutsche Aerospace A.G., Germany; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 8 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Today, available radar instruments cannot be applied for flight guidance purposes due to lack of resolution and ground elevation information. On the other side, optical sensors such as infrared systems provide an excellent resolution but are nearly blind at adverse weather conditions such as fog and rain. A new radar technology called ROSAR (Synthetic Aperture Radar based on ROtating antennas) promises to overcome the deficiencies of the traditional radar systems. On the basis of encouraging research work on ROSAR-technology and an investigation of the feasibility of a piloting system based on these ideas, Eurocopter Deutschland and Deutsche Aerospace started a development program called HeliRadar to develop a ROSAR-based piloting system. This device should be able to provide photolike images even under extreme visibility conditions. Details on the investigation and the resulting concepts for synthetic vision based flight guidance at Eurocopter will be given. Following an

introduction to the basics of ROSAR-technology, the technical concept of HeliRadar will be presented. The paper concludes with a discussion of the perspectives for civil and military applications.
Derived from text
Autorotation; Infrared Instruments; Military Helicopters; Military Technology; Optical Measuring Instruments; Radar Antennas; Synthetic Aperture Radar; Technology Assessment

19960003850 Advisory Group for Aerospace Research and Development, Sensor and Propagation Panel, Neuilly-Sur-Seine, France
HIGH POWER MICROWAVES (HPM), VOLUME 1 *LES MICRO-ONDES DE FORTE PUISSANCE (MFP)*
Mar 1, 1995; 277p; In English; In French; Sensor and Propagation Panel Symposium, 2-5 May 1994, Ottawa, Ontario, Canada; See also 19960003851 through 19960003880
Report No.(s): AGARD-CP-564; Copyright Waived; Avail: CASI; A13, Hardcopy; A03, Microfiche; Original contains color illustrations

This publication contains the unclassified papers presented to a specialists' meeting sponsored jointly by the Sensor and Propagation Panel and the Defence Research Group (DRG) of NATO. The topics covered in that meeting on the subject of 'High Power Micro-Waves (HPM)' included these: (1) High Peak Power Generators; (2) Transmission Line and Antenna Peak Power Handling; (3) Atmospheric Microwave Breakdown; (4) Target Coupling Mechanisms; (5) Components and Subsystems Vulnerability; (6) Hardening Against HPM; and (7) Test Facilities.
Conferences; Electric Generators; Electromagnetism; Electronic Warfare; Microwave Antennas; Microwave Equipment; Microwaves; Transmission Lines

19960003857 Defence Research Establishment Ottawa, Dept. of Mathematics and Computer Science., Ottawa Ontario, Canada
TRANSIENT ANTENNA DESIGN PARAMETERS FOR OPTIMIZING RADIATED PULSE
Lambert, A. P., Defence Research Establishment Ottawa, Canada; Booker, S. M., Defence Research Establishment Ottawa, Canada; Smith, P. D., Defence Research Establishment Ottawa, Canada; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 12 p; In English; Sponsored by the Defence Research Agency, UK; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Antenna structures capable of supporting (essentially) transverse electromagnetic (TEM) spherical wave are characterized by their frequency independence over a wide band width, making them ideal candidates for transient field generation and reception. In particular, the triangular plate configuration of the TEM horn is of interest for a variety of directive wide band applications, including nuclear EMP simulation, impulsive field detection, ultra-wide-band radar pulse transmission, and feeds for paraboloidal reflector antenna systems. The basic design for such structures is based on that of idealized, infinitely long, conical antennas. However, in producing practical antennas, which optimize the required characteristics of the radiated pulse train, several modifications to the original design are possible. This paper will discuss two particular features of the TEM horn design: the prediction of the characteristic impedance for a given structure and the effect of the horn profile on the output pulse.
Author
Antenna Arrays; Antenna Design; Design Analysis; Electrical Impedance; Reflector Antennas; Spherical Waves

19960003858 Defence Research Establishment Ottawa, Ottawa Ontario, Canada
ANALYSIS OF INTERACTION OF HPM WITH COMPLEX STRUCTURES
Kashyap, S., Defence Research Establishment Ottawa, Canada; Louie, A., Defence Research Establishment Ottawa, Canada; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 9 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper concerns the use of time- and frequency-domain methods for computing the interaction of high power microwaves with simple and complex structures. Effects of various factors - the geometric modelling of the structure, the Fourier transformation, the shape of the incident pulse, etc. - on the CPU-time and the accuracy of the solution are demonstrated. Results of our computations for various structures are presented.
Author
Electromagnetic Interactions; Frequencies; Microwaves; Time Dependence; Variable Geometry Structures

19960003859 Deutsche Aerospace A.G., Ulm, Germany
A PROCEDURE BASED ON LINE THEORY FOR CALCULATING SURFACE CURRENTS AND COUPLING INTO THE INTERIOR OF LARGE OBJECTS
Arnold, E., Deutsche Aerospace A.G., Germany; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

For objects which are too large to be calculated with the MM or the FDTD an approximation based on line theory was developed. For calculating an object a wire grid model is made. This model is described by Z-Matrix coefficients which are calculated approximately using line theory. The coupling of the wires are taken into account. Having the Z-matrix takes less effort to determine the currents at some special points of the object. Though the procedure is designed for the calculation of big objects compared to a wavelength, some results for simple objects are shown and compared with the results received by different methods.
Author
Approximation; Finite Difference Theory; Grid Generation (Mathematics); Matrices (Mathematics); Wire

19960003860 Toronto Univ. Ontario, Dept. of Electrical and Computer Engineering.; **Canada**
FREQUENCY-DOMAIN ANALYSIS ON NONLINEARLY LOADED THIN-WIRE ANTENNAS AND NETWORKS
Noujeim, Karam M., Toronto Univ. Ontario, Canada; Zaky, Safwat G., Toronto Univ. Ontario, Canada; Balmain, Keith G., Toronto Univ. Ontario, Canada; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 5 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Electronic devices are susceptible to a wide variety of high-level electromagnetic interference signals, from medium to microwave frequencies. The ability to assess the susceptibility of these devices to interference using computational techniques is an important asset to the designer. An essential ingredient in this process is the ability to combine linear field computations with nonlinear circuit analysis. A frequency-domain based computer program, known as TWIRE, has been developed for the periodic steady-state analysis of thin-wire antennas and scatterers loaded with nonlinear circuits. In addition to linear and nonlinear resistors, capacitors, and inductors, these circuits may contain transformers, diodes, transistors, N-port networks, etc. The computer program is based on an S-parameter technique that combines the thin-wire of moments with a frequency-domain-based nonlinear circuit simulator employing harmonic balance. The program is applicable to arbitrary-size wire networks and antenna structures loaded with circuits such as amplifiers, attenuators, detectors, filters, multipliers, and mixers. The program has been tested on various nonlinearly loaded antennas structures. Its predictions are found to be in agreement with measured results, and with analytical results published in the literature.
Author
Antenna Components; Computer Programs; Electric Networks; Electromagnetic Interference; Microwave Frequencies; Nonlinearity; Wire

19960003861 Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn, Germany
HPM COUPLING TO A CYLINDRICAL TARGET WITH SELECTED BUILT-IN COMPONENTS
Magg, M., Industrieanlagen-Betriebsgesellschaft m.b.H., Germany; Nitsch, J. B., NBC Defense Research and Development Inst., Germany; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A numerical simulation of HPM coupling to small missiles is described. The main interest is the current induced on the interior cabling in the resonance region. The results of the numerical solution

agree very well with real measurements performed on a test model. For a more realistic missile design we will find a very big reduction of the HPM coupling into the missile if its metallic fin system is replaced by a non-conducting one. Finally, we comment on the relation between maximum possible response and the shape of the incident microwave pulse.
Author
Cylindrical Bodies; Electromagnetic Coupling; Microwaves; Missile Design; Targets

19960003862 Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Euskirchen, Germany
COUPLING MEASUREMENTS ON INTELLIGENT MISSILES AT MICROWAVE FREQUENCIES
Braun, CH., Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Germany; Guidi, P., Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Germany; Schmidt, H. U., Fraunhofer-Inst. fuer Naturwissenschaftlich- Technische Trendanalysen, Germany; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 13 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes our low power microwave coupling measurements on terminally guided missiles in the frequency range between 100 and 8000 MHz. The plane wave excitation experiments have been carried out in our field coupling facility, which consists of an asymmetric triplate transmission line with maximum field levels of about 40 V/m in the working volume. As test objects we examined five (semi) autonomous guided missiles. Three of them, former experimental studies from the Diehl company (GE), are presented in this paper. The test objects were positioned in the simulator in three orthogonal orientation with respect to the external field and were not connected to a power supply (inactive condition). In order to be able to systematically analyze the interaction of the external electromagnetic fields with the avionics and its wiring, we had to divide the investigations into three independent phases, namely, external interaction with the fuselage, mode of penetration to the interior of the missile and excitation of the electrical systems and the cabling. The coupling paths depend very much on the design principles of the airframe. The main threat identified was back door coupling via those wings and fins, which are not attached galvanically to the outer surface of the hull. Because of flight guidance, these parts are fastened through slots to the bearings of the motor drives inside the missile. The dominant cable resonances sometimes can be traced back to the resonances of the wings and/or fins and the type of cabling. Another threat was coupling via the long slots required for the folding wings. These shafts penetrate the whole body and enable the external fields to couple into the interior. The peak amplitudes at the ends of the cables were found to be between 50 to 500 (micro A/(V/m)), depending on the test object.
Author
Airframes; Avionics; Microwave Coupling; Microwave Frequencies; Missiles; Plane Waves; Transmission Lines; Wiring

19960003863 Diehl G.m.b.H. und Co., Roethenbach, Germany
HIGH POWER MICROWAVE HAZARD FACING SMART AMMUNITIONS
Bohl, J., Diehl G.m.b.H. und Co., Germany; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 12 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The battle field of the present and even more the one in future will be characterized by the use of weapon systems with a high degree of electronics, computers, and sensors, designed and built to keep not only the man out of the loop. But the higher the technology used for smart weapon systems, the more these systems are endangered by numerous sources of hazard. One of those sources is the threat caused by induced or natural electromagnetic fields. These threat factors can be generated by natural, civil and military environment. In principle there are two main applications which must be considered in military applications: Firstly, weapon systems, that is, high power microwave sources as well as intelligent electromagnetic radiation systems to defeat ammunition on the battle field and secondly, the hardening of the own smart ammunition systems and missiles against the interference sources created by the different types of electromagnetic fields. This report will discuss the possible electromagnetic coupling effects on smart ammunition and missiles and their typical interference caused on the electronics and sensor level. Real time 6-DOF simulations show the flight mission which may be compromised depending on the coupled electromagnetic fields. The German MOD has established a research program where smart ammunitions with different seeker systems are investigated in respect of the coupling effects on smart ammunition caused by high power microwaves. This program considers all available resources and know how in Germany. The systems are investigated by analytical, numerical, and experimental methods with passive and activated missiles.
Author
Hazards; Microwave Coupling; Microwaves; Military Technology; Missile Control; Radiation Sources; Radio Control; Weapon Systems

19960003864 Defence Research Establishment Ottawa, Ottawa Ontario, Canada
CALCULATION AND MEASUREMENT OF HPM FIELDS SCATTERED BY A TARGET WITH OPENINGS
Kashyap, S., Defence Research Establishment Ottawa, Canada; Burton, M., Defence Research Establishment Ottawa, Canada; Louie, A., Defence Research Establishment Ottawa, Canada; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 6 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper concerns the computation and measurement of HPM (High Power Microwaves) fields inside and outside a structure with openings. RCS computations and measurements are made for a number of targets. The computations use both frequency-domain and time-domain methods, and the results are then compared with those measured in an anechoic chamber. An attempt is made to correlate various quantities such as the RCS, the scattered fields inside a structure, and the time-domain scattered far-fields. It is shown that some of the scattered far-field quantities may be used to identify the target scattering centers, the frequencies at which maximum coupling occurs, and the cut-off frequencies of a target.
Author
Apertures; Electromagnetic Fields; Frequency Response; Microwave Scattering; Microwaves; Temporal Distribution; Time Dependence

19960003865 Delegation Generale de l'Armement, Gramat, France
COUPLING ANALYSIS BY A RAPID NEAR FIELD MEASUREMENT TECHNIQUE *ANALYSE DU COUPLAGE PAR UNE TECHNIQUE DE MESURE RAPIDE DE CHAMP PROCHE*
Chevalier, B., Delegation Generale de l'Armement, France; Serafin, D., Delegation Generale de l'Armement, France; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 6 p; In French; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche; Original contains color illustrations

This paper presents a method for coupling analysis allowing to determine the worst case of stress (frequency, polarization and attitude angles) of a target by an electromagnetic wave. The approach is based on the determination of the radiated pattern of the device under test, considered as a transmitting antenna, using near field measurements. The coupling can be determined using the reciprocity theorem.
Author
Cross Sections; Electromagnetic Interactions; Microwave Coupling; Near Fields; Reciprocity Theorem; Stress Analysis

19960003866 Defence Research Agency, Seveuales, United Kingdom
INVESTIGATION OF RF COUPLING WITH UWB RADAR
Taylor, A. J. E., Defence Research Agency, UK; Clement, R. A., Defence Research Agency, UK; Hall, C., Defence Research Agency, UK; Parkes, D. M., Defence Research Agency, UK; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 4 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Direct experimental investigations of the coupling of microwave to military systems involves technically difficult instrumentation of the equipment. The problems associated with instrumenting the equipment can be avoided by exploiting the properties of ultrawideband radar. Illumination of a target by a short duration, fast risetime electromagnetic pulse results in a back scattered response which is formed by a combination of the early reflections of the incident pulse, and later natural resonances of the object. We compare experimental and

computational studies of the responses of a generic missile seeker head in order to assess what impulse radar reveals about coupling to a target.
Author
Electromagnetic Coupling; Electromagnetic Pulses; Impulses; Microwave Equipment; Radar Targets; Radio Frequencies; Radio Frequency Interference

19960003868 Defence Research Establishment Ottawa, Electronic Warfare Div., Ottawa Ontario, Canada
ELECTROMAGNETIC SHIELDING PROPERTIES OF COMPOSITE MATERIALS
Gardner, C. L., Defence Research Establishment Ottawa, Canada; Apps, R., Defence Research Establishment Ottawa, Canada; Russell, A. J., Defence Research Establishment Pacific, Canada; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 12 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

In order to ensure that composite structures have adequate electromagnetic (EM) shielding, a knowledge of the EM properties of anisotropic laminated materials is necessary. In this paper, we provide an overview of work we have carried out to measure the intrinsic EM shielding properties of carbon and non-carbon epoxy laminates. These experimental results are compared with numerical results that have been calculated using the Method of Moments. Finally, results showing the effect of repair of carbon/epoxy composites on shielding properties are presented.
Author
Anisotropic Media; Composite Structures; Electromagnetic Shielding; Epoxy Matrix Composites; Laminates

19960003869 Defence Research Establishment Ottawa, Ottawa Ontario, Canada
HARDENING AGAINST A COMBINED ELECTROMAGNETIC THREAT
Dion, M., Defence Research Establishment Ottawa, Canada; Gardner, C., Defence Research Establishment Ottawa, Canada; Kashyap, S., Defence Research Establishment Ottawa, Canada; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Hardening against the electromagnetic environment is usually done by considering each threat separately. In recent years, there has been an increasing interest in methods for unifying electromagnetic standards and procedures to simplify the design and testing of hardening techniques. This approach is appealing as it could reduce the cost of system design as well as the cost of testing. The objective of this paper is twofold: firstly, to assess the feasibility of combining the various electromagnetic threats to simplify the design of electromagnetic protection; and secondly, to assess the feasibility of using a single test, or at least a minimum number of tests, to verify the electromagnetic hardness of a system.
Author
Electromagnetic Interference; Electronic Equipment; Electronic Equipment Tests; Electronic Warfare; Radiation Hardening

19960003870 Polytechnic Univ., Research Inst., Farmingdale, NY, United States
MODELING AND NUMERICAL SIMULATION OF MICROWAVE PULSE PROPAGATION IN AIR BREAKDOWN ENVIRONMENT
Kim, J., Polytechnic Univ., USA; Kuo, S. P., Polytechnic Univ., USA; Kossey, Paul, Phillips Lab., USA; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 9 p; In English; Sponsored by AFOSR Contract(s)/Grant(s): NAG5-1051; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

It is shown that ionization occurs wherever the field intensity of the pulse exceeds the local breakdown threshold field of the background air. The produced plasma then attenuates the pulse and gives rise to a tail erosion phenomenon that plays the primary role in limiting the energy transfer of the pulse from source to destination. A theoretical model describing the propagation of an intense microwave pulse in an air breakdown environment is developed that includes the possible focusing effect introduced by either using phase array antennas or the other arrangements. The self-consistent description of the propagation process is provided by a set of two modal equations. These include a continuity equation (Poynting's equation) for the energy density of the pulse and a rate equation of the electron density. A forward wave approximation is used to simplify Poynting's equation, and a semiempirical formula is used for the ionization frequency, nu(sub i). This frequency provides the coupling between the two modal equations, and is used to express the electron rate equation explicitly. In terms of the relevant parameters of the atmosphere, these two equations are normalized for numerical analysis of pulse propagation in the atmosphere. The dependencies of the propagation characteristics of the pulse on intensity, frequency, width, and shape of the pulse are determined. The numerical simulations lead to a useful empirical relation p(exp 3)w = alpha = constant, where p and w are the incident power and width of the pulse and alpha depends on the percentage of pulse energy transferred from the source point to a destined position. The density distribution of the pulse's self-generated plasma is also evaluated. The results also show that for ionization caused by a single unfocused microwave pulse transmitted upwards from the ground, the maximum electron density produced at, for example, 50 km altitude is limited by the tail erosion effect to below 10(exp 6) cm(exp -3). Repetitive pulse and focused beam approaches are also examined. Both approaches can increase the maximum electron density by no more than an order of magnitude. A scheme using two obliquely propagating pulses intersecting at the destined height, e.g. 50 km, is considered. It is shown that the electron density generated at the lowest intersecting position can easily reach a value of 6.6 x 10(exp 8) cm(exp -3), which is considered to be high enough for artificial ionospheric mirror (AIM) application.
Author
Atmospheric Attenuation; Atmospheric Ionization; Electromagnetic Pulses; Electron Density (Concentration); Ionization Frequencies; Mathematical Models; Microwave Transmission; Poynting Theorem

19960003871 University of Western Ontario, Dept. of Electrical Engineering., London Ontario, Canada
A REVIEW OF NONLINEAR ELECTROMAGNETIC PROPAGATION EFFECTS
Lovetri, Joe, University of Western Ontario, Canada; Wartak, Marek S., Wilfrid Laurier Univ., Canada; Siushansian, Riaz, University of Western Ontario, Canada; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 9 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

It is well known that the presence of intense electromagnetic waves in media which is normally linear will have the effect of producing a nonlinear constitutive relation (D = epsilon(E)E). This paper reviews the fundamentals of nonlinear electromagnetic wave propagation with the goal of trying to coalesce the main features of this type of problem. The features of these important nonlinear effects are summarized and the way in which they manifest themselves mathematically into Maxwell's equations is reviewed. For example, in fiber optics the nonlinearities in the permittivity of the fiber have extreme consequences for the governing propagation equations (a nonlinear Schroedinger equation is derived). We identify important nonlinear mechanisms and analyze their basic physical contents. For that purpose many important analogies between propagation of intense nonlinear pulses in optical fibers and microwave pulses in the atmosphere are drawn and analyzed. The applications wherein these effects arise are then surveyed, some of these being intentional while others may be unwanted. The resulting nonlinear effects in fiber optics applications are very interesting (soliton propagation) and of practical importance in transocean telecommunication. Generation, detection, and propagation of optical solitons has been demonstrated over distances as long as 15,000 km. The soliton laser, which utilizes Kerr nonlinearity in optical fiber, has also been demonstrated. In the case of the propagation of radio waves and microwaves through the ionosphere these effects may be undesirable but can be put to use in order to localize or columnize the beam. Thus, for the production of soliton waves in fiber optics and for the columnization of high power microwaves, the nonlinearities are essential. Next, some of the modeling techniques which are available for some of the nonlinear problems are

surveyed and explained. Numerical results for nonlinear electromagnetic propagation are reviewed. Finally, future problems resulting from the inclusion of nonlinearities are addressed.
Author (revised)
Beams (Radiation); Electromagnetic Radiation; Electromagnetic Wave Transmission; Fiber Optics; Maxwell Equation; Nonlinear Equations; Nonlinear Optics; Plasma-Electromagnetic Interaction

19960003872 Polytechnic Univ., Research Inst., Farmingdale, NY, United States
SPECTRAL VARIATION OF HIGH POWER MICROWAVE PULSE PROPAGATING IN A SELF-GENERATED PLASMA
Ren, A., Polytechnic Univ., USA; Kuo, S. P., Polytechnic Univ., USA; Kossey, Paul, Phillips Lab., USA; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 10 p; In English; Sponsored by AFOSR Contract(s)/Grant(s): NAG5-1051; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A systematic study to understand the spectral variation of a high power microwave pulse propagating in a self-generated plasma is carried out. It includes the theoretical formulation, experimental demonstration, and computer simulations and computer experiments. The experiment of pulse propagation is conducted in a vacuum chamber filled with dry air (approximately 0.2 torr); the chamber is made of a 2 ft. cube of Plexiglas. A rectangular microwave pulse (1 microsec pulse width and 3.27 GHz carrier frequency) is fed into the cube through an S band microwave horn placed at one side of the chamber. A second S-band horn placed at the opposite side of the chamber is used to receive the transmitted pulse. The spectra of the incident pulse and transmitted pulse are then compared. As the power of the incident pulse is only slightly (less than 15%) above the breakdown threshold power of the background air, the peak of the spectrum of the transmitted pulse is upshifted from the carrier frequency 3.27 GHz of the incident pulse. However, as the power of the incident pulse exceeds the breakdown threshold power of the background air by 30%, a different phenomenon appears. The spectrum of the transmitted pulse begins to have two peaks. One is upshifted and the other one downshifted from the single peak location of the incident pulse. The amount of frequency downshift is comparable to that of the upshifted frequency. A theoretical model describing the experiment of pulse propagation in a self-generated plasma is developed. There are excellent agreements between the experimental results and computer simulations based on this theoretical model, which is also used to further carry out computer experiments identifying the role of plasma introduced wave loss on the result of frequency downshift phenomenon.
Author
Atmospheric Ionization; Electromagnetic Pulses; Frequency Shift; Microwave Spectra; Microwave Transmission; Plasma-Electromagnetic Interaction; Spectrum Analysis

19960003877 Thomson Tubes Electroniques, Velizy, France
UPGRADING OF THE RF TUBES OF THE PRESENT STATE OF THE ART
Faillon, Georges, Thomson Tubes Electroniques, France; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 7 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Although basic studies are far from completion, the microwave levels requested for the vulnerability test benches are far below those expected on HPM weapons. At the same time, the main requirements of the test benches are accuracy and reliability, therefore the sources to be used can be derived from the existing high power sources commonly used in several fields such as radars, particle accelerators, thermonuclear fusion, etc. For example, the development of klystron amplifiers delivering 100 to 200 MW in S band with 1 microsec pulse length is in progress. In shorter pulses (10's of ns) relativistic magnetrons (below the X or C band) and BWO's (beyond the X band) begin to be easy to bring into operation. Nevertheless amplifiers seem more attractive because their pulses shapes, their frequencies and their phases are entirely controlled. The bandwidth is also an important technical characteristic. Devices such as pulse compressors upgrade existing tubes. The single cavity, plasma switch compressor transforms for example a 50 kW 2 microsec pulse into 3 MW, 5 ns in X band and the same principle can be applied to provide up to 50 to 200 MW according to the frequency.
Author
Klystrons; Magnetrons; Microwave Amplifiers; Microwave Frequencies; Microwaves; Pulse Compression; Sensitivity; Weapon Systems

19960003878 MATRA Marconi Space, Toulouse, France
THE NUMERICAL MODELLING OF NEAR-FIELD HPM TARGET COUPLING
Soubeyran, A., MATRA Marconi Space, France; Estienne, J. P., MATRA Marconi Space, France; Boeuf, J. P., Toulouse Univ., France; Ravier, A., MATRA Defense Espace, France; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 7 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The numerical simulation of the coupling of HPM waves on targets is investigated either in vacuum (e.g. satellites) or in the atmosphere (e.g. aircraft's) using integral methods for unstructured meshing.
Author
Dense Plasmas; Electromagnetic Fields; Electromagnetic Radiation; Finite Volume Method; Mathematical Models; Method of Moments; Microwaves; Near Fields; Plasma-Electromagnetic Interaction; Targets

19960003879 Thomson Shorts Systems, Bagneux, France
TEST LABORATORY FOR HIGH LEVEL MICROWAVES *LABORATOIRE D'ESSAIS FIER DE FORT NIVEAU HYPERFREQUENCE*
Brasile, J. P., Thomson Shorts Systems, France; Jean-Francois, G., Thomson Shorts Systems, France; Simon, M., Thomson Shorts Systems, France; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 6 p; In French; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A laboratory for high level microwaves was studied and carried out by Thomson Shorts Systemes. This installation produced: strong powers ultra high frequency (1 GW Peak), and radiated strong fields. The possibilities of this installation allow the user to carry out strong tests of vulnerability in fields of high level microwaves, and to be used as technological demonstrator implementing strong pulsed voltages (1 MV) of strong currents (a few tens of kA) and large power radiated ultra high frequencies (1 GW).
Author
Electromagnetic Pulses; Performance Tests; Pulse Duration; Ultrahigh Frequencies

19960003880 Phillips Lab., Electromagnetic Sources Div., Kirtland AFB, NM, United States
RADIAL ACCELETRON: A NEW LOW-IMPEDANCE HPM SOURCE
Arman, Moe Joseph, Phillips Lab., USA; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 11 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Under a grant from the National Research Council and in collaboration with the Phillips Laboratory, the author was tasked to explore and analyze the proposed concept of using transit-time effects in a coaxial geometry to develop a low-impedance HPM source that uses no external magnetic field and no confining foils. This source will work in the 1-20 GHz range and will have a power output of no less than 1 GW. The input will be a low-voltage dc pulse of only 350kV or less with a flat top of approximately 200ns. The dc pulse is launched into a coaxial structure that is the diode, the oscillator, and the buncher all in one. Strong impedance mismatch between the diode section and the body of the device provides enough reflection to have a well defined coaxial cavity of high Q to support cavity characteristic modes. Electrons are emitted from the inner conductor of the structure and as they accelerate towards the anode they interact with a selected characteristic mode of the structure, on the average losing kinetic energy to the mode. This process continues until the RF fields are strong enough to modify the transit time away from the optimal value thus leading to saturation. The source offers significant improvements in power, repetition rate, size, and efficiency. Because of the coaxial structure, the diode impedance may be reduced to a few ohms thus allowing larger input and output powers. With no foils to erode, the only thing limiting the repetition rate is the vacuum ability, and since there is no external magnetic field required, the device is simple, lightweight and inexpen-

sive. Because of the strong bunching the efficiency is high. As is the case with all transit-time oscillators, the signal is stable and monochromatic. The device may be used as a buncher or as an oscillator. In what follows I present the progress made so far and show that all goals set forth in this project are achieved. In addition it is shown that the gated emission of electrons, a process basic to high power rf-amplification, is a natural by-product of the mechanism used in this device.
Author
Cavities; Computerized Simulation; Electric Charge; Electromagnetic Radiation; Fourier Transformation; Impedance Matching; Microwaves; Particle Acceleration; Particle Accelerators; Particle Beams; Q Factors; Transit Time

19960003896 Office National d'Etudes et de Recherches Aerospatiales, Direction des Estudes de Synthese., Paris, France
SPACEBORNE SAR SIMULATION USING AIRBORNE DATA
Boutry, J.-M., Office National d'Etudes et de Recherches Aerospatiales, France; Dupas, J., Office National d'Etudes et de Recherches Aerospatiales, France; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 9 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The synthetic aperture technique, together with a procedure to make up wide band pulses, enables achievement of high resolution bidimensional images of the ground with a side-looking airborne radar system. With some kinds of transpositions, such images, gathered during an airborne campaign, are significant of results in a space-based context.
Author
Airborne Radar; Calibrating; Image Analysis; Imaging Radar; Radar Data; Side-Looking Radar; Simulation

19960007226 Advisory Group for Aerospace Research and Development, Sensor and Propagation Panel, Neuilly-Sur-Seine, France
PROPAGATION ASSESSMENT IN COASTAL ENVIRONMENTS ***L'EVALUATION DE LA PROPAGATION EN REGIONS COTIERES***
Feb 1, 1995; 345p; In English; In French; Sensor and Propagation Panel Symposium, 19-22 Sep. 1994, Bremerhaven, Germany; See also 19960007227 through 19960007262
Report No.(s): AGARD-CP-567; ISBN 92-836-0013-4; Copyright Waived; Avail: CASI; A15, Hardcopy; A03, Microfiche

This publication reports the unclassified papers at a specialists' meeting held by the Sensor and Propagation Panel at its Fall 1994 meeting. The topics covered on the occasion of that symposium on the subject of 'Propagation Assessment in Coastal Environments' included: (1) Radio Propagation Modeling; (2) Electro-optical Propagation Modeling; (3) Remote and Direct Sensor and Sensing Techniques; (4) Modeling and Prediction of the Propagation Environment; (5) Sensor Technology and Systems Aspects; and (6) Measurement Campaigns.
Coasts; Conferences; Electro-Optics; Marine Environments; Radio Transmission; Remote Sensors; Wave Propagation

19960007231 Nantes Univ.; **France**
BISTATIC STUDY OF THE POLARIMETRIC BEHAVIOR OF THE OCEANS ***ETUDE BISTATIQUE DU COMPORTEMENT POLARIMETRIQUE DES OCEANS***
Daout, F., Nantes Univ., France; Khenchaf, A., Nantes Univ., France; Hurtaud, Y., Centre d'Electronique de l'Armement, France; Saillard, J., Nantes Univ., France; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 13 p; In French; See also 19960007226; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper covers the general topic of remote sensing and radio propagation above the sea surface. A study concerning scattering methods on the oceanic surface is first presented, followed by the search of the polarimetric signature of the sea surface, as a function of the observation parameters and some theoretical scattering models. A technique of polarimetric optimization is finally developed to increase the reliability of the radio link as well as to improve the radar accuracy.
Author
Ocean Surface; Oceans; Polarimetry; Radio Transmission; Reliability; Remote Sensing

19960007232 Johns Hopkins Univ., Applied Physics Lab., Laurel, MD, United States
ATMOSPHERIC DATA RESOLUTION REQUIREMENTS FOR PROPAGATION ASSESSMENT: CASE STUDIES OF RANGE-DEPENDENT COASTAL ENVIRONMENTS
Dockery, G. Daniel, Johns Hopkins Univ., USA; Goldhirsh, Julius, Johns Hopkins Univ., USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 13 p; In English; See also 19960007226
Contract(s)/Grant(s): N00039-94-C-0001; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

With the proliferation of efficient, accurate, range-dependent propagation models, the largest remaining challenge in shipboard environmental assessment is obtaining high-resolution atmospheric data for use in these models. Due to the difficulty of acquiring data in all directions from a ship, it is particularly important to establish what horizontal separation between atmospheric profiles is adequate for accurate shipboard assessment. It is equally important to determine the minimum acceptable resolution in the vertical direction. In order to begin to investigate these spatial sampling requirements, this paper examines two sets of high-resolution atmospheric data collected along the east and west coast of the U.S. These data were collected by an instrumented helicopter in support of U.S. Navy propagation experiments and tests. The sampling necessary to represent significant atmospheric structures is discussed, and an accurate propagation model is used to examine the sensitivity of propagation predictions to vertical and lateral data resolution. Results are presented for 3 and 10 GHz to examine the frequency dependence of resolution effects.
Author
Atmospheric Effects; Atmospheric Refraction; Coasts; High Resolution; Radio Transmission

19960007234 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States
TERRAIN AND REFRACTIVITY EFFECTS IN A COASTAL ENVIRONMENT
Barrios, Amalia E., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 6 p; In English; See also 19960007226; Sponsored by Dept. of Trade and Industry, UK; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Results from the VOCAR (variability of coastal atmospheric refractivity) experiment, performed in the southern California coastal area, are presented and compared with a terrain parabolic equation model called TPEM. Both homogeneous and range dependent refractivity environments are considered.
Author
Coasts; Mathematical Models; Parabolic Differential Equations; Radio Transmission; Radio Wave Refraction; Refractivity; Terrain; Variability

19960007235 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States
MODELING NONPERFECT REFLECTION FROM THE SEA FOR RANGE-DEPENDENT DUCTING CONDITIONS
Hitney, Herbert V., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 6 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper describes an approximate method to account for nonperfect reflection from the sea that uses a simple technique to modify a parabolic equation (PE) model based on sine fast Fourier transforms (FFT's). Although the method is an approximation, it gives good results compared to other more rigorous models, and is very efficient. Comparisons of results for ducting conditions that are homogeneous with range using the approximate, waveguide, and mixed transform PE methods are presented to evaluate the approximate method. The approximate method is easily extended to range-dependent ducting and roughness conditions likely to be encountered in coastal

environments. to evaluate these cases, a comparison is made of approximate method results and results from a mixed-transform PE model for vertical polarization.
Author
Approximation; Coasts; Fast Fourier Transformations; Mathematical Models; Ocean Surface; Parabolic Differential Equations; Radio Transmission; Wave Reflection

19960007236 Johns Hopkins Univ., Applied Physics Lab., Laurel, MD, United States
A PROPAGATION-BASED MODEL OF TERRAIN EFFECTS FOR SHIP-BOARD RADAR APPLICATIONS
Reilly, J. P., Johns Hopkins Univ., USA; Lin, C. C., Johns Hopkins Univ., USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 12 p; In English; See also 19960007226; Sponsored by US Navy AEGIS Shipbuilding Program; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

In this paper, a site-specific approach is presented to characterize terrain and target visibility and terrain clutter as seen by a ship-board radar in a coastal environment. The method takes into account the location of the ship, the particular terrain topography, the radar parameters, and the propagation effect. The method incorporates refractive index models of the atmosphere surrounding the radar, an optical ray-trace model, an electromagnetic parabolic equation model, and a data base of terrain elevations. The model can simulate illumination and shadow regions of both surface clutter and elevated targets. Simulated clutter results are shown to compare favorably with clutter data measured at S-band. This correspondence is evident in geographic patterns and statistical distribution of clutter on directly illuminated terrain surfaces.
Author
Atmospheric Effects; Atmospheric Refraction; Clutter; Coastal Water; Coasts; Radar Targets; Radar Transmission; Refractivity; Terrain

19960007237 Naval Research Lab., Marine Meteorology Div., Monterey, CA, United States
OPERATIONAL SUPPORT FOR A RANGE-DEPENDENT RADIO PROPAGATION MODEL
Cook, John, Naval Research Lab., USA; Vogel, Gerard, Naval Research Lab., USA; Love, Gary, Naval Research Lab., USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 8 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The emerging new standard in the U.S. Navy for range-dependent radio propagation assessment is the Radio Physical Optics (RPO) model developed at the Naval Command, Control and Ocean Surveillance Center, RDT&E Division (NRaD). RPO allows one to compare the expected radio propagation loss field as a function of height along a desired bearing, provided the atmospheric propagation conditions are specified along the path. This paper describes an architecture being developed to operationally support RPO. In developing this architecture, a number of unique constraints and considerations have been dealt with to provide RPO with cross-sections of atmospheric propagation conditions. First, forecast grids from a mesoscale weather data assimilation/prediction model are accessed to provide the best estimate of the current and future refractive and meteorological conditions over the area of interest. Based on conditions near the surface, high-resolution profiles of refractivity in the evaporation duct are calculated and appended onto the bottom of the model forecast profiles. This completes the specification of refractivity down to the sea surface. These refractivity profiles are then processed by a unique algorithm that matches similar refractivity structures from profile-to-profile and reformats the data to support the indexing scheme required by RPO. After RPO has been run, the propagation loss results can be displayed and thresholded to provide expected coverage against specific targets. An example will be shown where multiple RPO runs are used to suggest positioning of available assets to maximize coverage.
Author
Atmospheric Effects; Atmospheric Refraction; Mesoscale Phenomena; Meteorological Parameters; Physical Optics; Radio Transmission; Refractivity

19960007238 Defence Research Establishment Valcartier, Courcellette Quebec, Canada
REFRACTION EFFECTS ON EO SYSTEM DETECTION RANGES IN COASTAL ENVIRONMENTS
Dion, Denis, Defence Research Establishment Valcartier, Canada; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 9 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Atmospheric refraction can significantly affect the detection range performances of electro-optical (EO) systems against low-level targets in coastal environments. Negative air-sea temperature difference (ASTD) conditions, which produce subrefraction, impose an absolute limit of detection range shorter than the terrestrial horizon, while positive ASTD conditions, which produce superrefraction, allow radiation to propagate beyond the horizon. For subrefraction conditions, an approximate formula is given for estimating the detection range limit as a function of ASTD, wind speed and sensor-target elevations. Under superrefraction, the detectability is degraded by the refraction-induced ray spreading near the sea surface. This refraction loss, which depends on the weather conditions and the sensor-target elevations, is discussed.
Author
Atmospheric Boundary Layer; Atmospheric Refraction; Atmospheric Temperature; Coasts; Electro-Optics; Ocean Surface; Ocean Temperature; Refractivity; Temperature Gradients

19960007239 California State Univ., Dept. of Aerospace Engineering., Long Beach, CA, United States
COMPARISON OF SIMULTANEOUS 3-5 AND 8-12 MICRO TRANSMISSION MEASUREMENTS NEAR THE OCEAN SURFACE
Bull, H. T., California State Univ., USA; Jensen, D. R., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 6 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A comparative transmissometer has been developed for evaluating the simultaneous transmission characteristics for near ocean surface transmissions in the 3-5 micron and 8-12 micron bands. This transmissometer is a special purpose instrument designed for simultaneously measuring the changes in transmission of the 3-5 micron and 8-12 micron transmission bands. The transmissometer has been operated over the San Diego Bay, California, to determine the transmission characteristics for near ocean propagation paths. Observed propagation characteristics for both the 3-5 micron and 8-12 micron bands are compared and discussed as a function of existing sea states and meteorological conditions. The observed transmission characteristics for the two wave bands are compared with LOWTRAN calculations. Rapid fluctuations in received signal strength, their power spectra, and correlation coefficients are also discussed.
Author
Electromagnetic Wave Transmission; Infrared Radiation; Ocean Surface; Oceans; Transmissometers

19960007246 Forschungsinstitut fuer Optik, Tuebingen, Germany
IMPACT OF COASTAL ENVIRONMENT ON POINT TARGET DETECTION
Stein, K., Forschungsinstitut fuer Optik, Germany; Kohnle, A., Forschungsinstitut fuer Optik, Germany; Schuberth, W., Forschungsinstitut fuer Optik, Germany; Jantzen, R., Forschungsinstitut fuer Optik, Germany; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 10 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

It is still difficult for a sensor system to detect low flying anti-ship missiles over long distances with high detection probability and low false alarm rates. In continuation of the work in this subject area concerning infrared (IR) sensor systems the FGAN-FfO participated in the MAPTIP trial of NATO AC/243 (Panel 04/RSG.08) with two infrared (IR) / visible (VIS) camera systems set-up on the Katwijk coast in The Netherlands. Two main types of measurements were performed. Observations of a fixed target mounted on a mast on the Meetpost Noordwijk platform 5.6 miles off the Katwijk coast, and tracks of planes, especially of the inbound flights of a Piper Navajo, chartered by the US-NCCOSC. Initial analysis results of the temporal and spatial behavior of the fixed and moving targets, especially the two engines of the Piper Navajo, are given. In addition, experimentally determined signal-to-noise ratios from IR imagery are compared with calculations

using the FGAN-FfO thermal range model for point target detection (TRP). The correspondence is quite good. It was possible to track the Piper Navajo up to 13 nautical miles (nmi) in the 8 - 12 micron waveband, less far in the 3 - 5 micron wavelength region. This was partially due to the lower sensitivity of the used sensor in this waveband. The two engines of the approaching place were resolved at 8 nmi. Steps have been undertaken to analyze the handle of extremely close multiple targets (as the two Navajo engines seen at long distance) by different image processing algorithms. One example is given where bispectrum analysis is used to clearly resolve the two Navajo engines at long distances. Forschungsinstitut fuer Optik (FfO, Research Institute for Optics) presents first results from their participation in the MAPTIP measurement campaign.
Author
Coastal Water; Coasts; Infrared Imagery; Target Acquisition; Target Recognition

19960007247 Defence Research Establishment Valcartier, Courcellette Quebec, Canada
MAPTIP: CANADA'S MEASUREMENTS OF REFRACTION EFFECTS
Forand, J. L., Defence Research Establishment Valcartier, Canada; Dion, D., Defence Research Establishment Valcartier, Canada; Beaulieu, J., Defence Research Establishment Valcartier, Canada; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 7 p; In English; See also 19960007226
Contract(s)/Grant(s): N00014-91-J-1948; NATO AC/243-6056; NATO AC/243-6092; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper presents some results obtained by Canada's Defence Research Establishment Valcartier (DREV) during the Marine Aerosol Properties and Thermal Imager Performance (MAPTIP) trial off the North Sea coast of The Netherlands during October 1993. Our study of refraction effects in the Marine Boundary Layer (MBL) in both the visible and infrared (IR) wavelength bands produced a large quantity of excellent experimental data. Along with data obtained from previous campaigns in both Canada and Germany, this data set is being used to test the validity of the WKD and the Wavy WKD (WWKD) models developed by DREV. These early results from the recent MAPTIP trial have shown that in general the predictions of the WWKD model agree remarkably well with the experimental data.
Author
Aerosols; Air Water Interactions; Atmospheric Boundary Layer; Atmospheric Models; Atmospheric Refraction; Coasts; Thermal Mapping

19960007250 Centre d'Etudes et de Recherches, Toulouse, France
OVERVIEW OF NATO/AC 243/PANEL 3 ACTIVITIES CONCERNING RADIOWAVE PROPAGATION IN COASTAL ENVIRONMENTS *TOUR D'HORIZON DES ACTIVITES DE L'OTAN/ AC243/COM.3 CONCERNANT LA PROPAGATION RADIOELECTRIQUE EN ZONE COTIERE*
Christophe, F., Centre d'Etudes et de Recherches, France; Douchin, N., Centre d'Etudes et de Recherches, France; Hurtaud, Y., Centre d'Electronique de l'Armement, France; Dion, D., Defence Research Establishment Valcartier, Canada; Makaruschka, R., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Heemskerk, H., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Anderson, K., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 9 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The performances of most systems operating at RF and millimeter waves can be seriously affected by propagation effects. That is the reason why NATO established the Research Study group No. 8 (RSG8) within Panel 3 (physics and electronics) of Defense Research Group (AC 243), with its Propagation Subgroup (PSG) responsible for the propagation aspects. Comparison of mm and other wavelengths was to be considered. In maritime and coastal environments, the use of such wavelengths for various military applications like anti-ship seekers, fire control radars, ship to ship communications or Electronic Support Measurements (ESM) led to the setting up of specific measurement campaigns; the last three are reported hereafter. The first two experiments used facilities close to Lorient, on the Atlantic coast, and Toulon, on the Mediterranean coast of France, with the purpose of documenting the refractive effects for medium range over the horizon paths. These experiments where are referred to as Lorient 89 and Toulon 90 campaigns, are described in this paper, and some typical results are presented. The latest cooperative work of RSG8/PSG took place recently (fall 1993) near Lorient, on a line-of-sight 10 km path over seawater. This experiment, referred to as Lorient 93 campaign, was devoted to the analysis of phase-front distortions due to multipath along with refractive effects, and to the assessment of performances for naval systems like short range tracking radars. Analysis of the data, either on a statistical base or as specific case studies, is being performed presently, but some early typical results will be given in this paper after a detailed description of the experiment.
Derived from text
Atmospheric Boundary Layer; Atmospheric Refraction; Coasts; Ocean Surface; Radio Frequencies; Radio Transmission; Radio Waves; Refractivity

19960007251 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Physics and Electronics Lab., The Hague, Netherlands
LORIENT CAMPAIGN 1993: THE DUTCH CONTRIBUTION
Boekema, R. B., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 8 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The performance of radar and infrared systems in a maritime environment is strongly dependent on the conditions of the atmosphere and the sea surface. In the autumn of 1993 an experiment was set up by the NATO Research Study Group AC/243 Panel3/RSG21 to collect propagation data at a line-of-sight propagation path. The purpose of the experiment was to gain knowledge about the behavior of the path loss and angle of arrival of the signals. This paper presents the results of the Dutch contribution to the experiment and a comparison of the measurements with model predictions. For radar in the line-of-sight situation the propagation is dominated by the multipath interference and influenced by ducting. Predictions performed with the propagation model PCPEMC and the Bulk-CELAR duct model show satisfying results for the position of the nulls, if wind speed and wave height are taken into account. Using the data of this experiment, a synergism between radar and IR angle of arrival could not be proven.
Author
Air Water Interactions; Electromagnetic Interference; Infrared Imagery; Infrared Radiation; Marine Meteorology; Multipath Transmission; Ocean Surface; Radar

19960007252 Ecoles de Coetquidan, Centre de Recherches., Guer, France
MODELING THE VERTICAL PROFILES OF THE INDEX OF REFRACTION AND (C(SUB N))(EXP 2) IN MARINE ATMOSPHERE *MODELISATION DES PROFILS VERTICAUX D'INDICE DE REFRCTION ET DE CN2 EN ATMOSPHERE MARINE*
Claverie, Jacques, Ecoles de Coetquidan, France; Hurtaud, Yvonick, Centre d'Electronique de l'Armement, France; Defromont, Yannick, Ecoles de Coetquidan, France; Junchat, Alain, Centre d'Electronique de l'Armement, France; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 11 p; In French; See also 19960007226; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The determination of the conditions of propagation, for systems evolving/moving in the CLSO (Boundary layer of Oceanic Surface), requires the knowledge of the vertical profile of index of refraction. From simple weather measurements, the model PIRAM (Profiles of Index of Refraction in Atmosphere Navy) makes it possible to calculate this profile starting from the vertical profiles of temperature and moisture. PIRAM takes again, with the help of some modifications, the step followed in the Bulk-CELAR model conceived initially for the radio frequencies. Calculations from now on were extended to the optical field. PIRAM also allows the modeling of the vertical profile of the structural parameter of the index of refraction of the air (C(sub n))(exp 2). This new modeling will have to be validated by experimental data. Near the coasts, the knowledge of the vertical profiles is however not always sufficient, because in particular of the horizontal inhomogeneousness of the channel of propagation.
Transl. by CASI
Atmospheric Boundary Layer; Atmospheric Composition; Atmospheric Models; Carbon; Coasts; Concentration (Composition); Ocean Surface; Refractivity; Vertical Distribution

19960007253 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States

AN OVERVIEW OF AN INTENSIVE OBSERVATION PERIOD ON VARIABILITY OF COASTAL ATMOSPHERIC REFRACTIVITY

Paulus, Richard A., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 6 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper is an overview of an experiment called Variability of Coastal Atmospheric Refractivity (VOCAR). VOCAR was designed to be conducted under a larger program called Coastal Variability Analysis, Measurements, and Prediction and is a multi-year experimental effort to investigate the variability of atmospheric refractivity with emphasis on the coastal zone. The experiment is being conducted jointly with the Naval Air Warfare Center Weapons Division, Point Mugu, CA, the Naval Research Laboratory, and the Naval Postgraduate School. In addition, the National Oceanic and Atmospheric Administration Environmental Technology Laboratory and Penn State University/Applied Research Laboratory are participating in the measurement phase of VOCAR. The propagation measurements being made during VOCAR consist of monitoring signal strength variations of VHF/UHF transmitters in the southern California coastal region. Corresponding meteorological measurements are made during routine, special, and intensive observation periods. During an intensive measurement period from 23 August to 3 September 1993, radio data were collected at two receiver sites and meteorological data were collected from three profiler sites, eight radiosonde sites, three aircraft, and numerous surface weather sites. Samples of the data will be shown.

Author

Atmospheric Refraction; Coasts; Meteorological Parameters; Radio Transmission; Variability

19960007254 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States

EFFECTS OF SPATIAL AND TEMPORAL VARIABILITY OF ATMOSPHERIC REFRACTIVITY ON THE ACCURACY OF PROPAGATION ASSESSMENTS

Rogers, L. Ted, Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 9 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Meteorological measurements indicating range dependent refractive structures have been documented by several observers. A central concern arising from these observations is the affect the assumption of horizontal homogeneity has on the accuracy of propagation assessments, where accuracy is defined as the difference between estimated and measured propagation loss. Complicating the discussion of variability are conflicting goals for propagation model performance versus propagation assessment system performance. With the former, the goal is to minimize error at the time of environmental observation used for the model inputs. With the latter, the goal is to minimize error over the time of use of propagation estimates, a period of time that is often measured in hours with the current level of environmental sensing technology. With these considerations in mind, the effect of spatial and temporal variability of the atmospheric refractive structure on real-time or nearly real-time radio frequency (RF) propagation assessment system performance is examined.

Author

Atmospheric Refraction; Meteorological Parameters; Radio Transmission; Refractivity; Spatial Distribution; Temporal Distribution; Variability

19960007255 Naval Air Warfare Center, Geophysics Div., Point Mugo, CA, United States

REFRACTIVE VARIABILITY DURING VOCAR 23 AUGUST TO 3 SEPTEMBER 1993

Helvey, Roger A., Naval Air Warfare Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 7 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Measurements of the lower atmosphere from the southern California coastal area were obtained from a number of sources during the 23 Aug. - 3 Sep. 1993 VOCAR Intensive Observation Period (IOP). Data from high-resolution radiosondes, surface stations, aircraft and weather satellite have been collected for use in identifying mesoscale atmospheric phenomena and related refractive features. Spatial and temporal variations in the height of the elevated duct associated with these phenomena are a major factor in determining refractive conditions in this region. An automated isentropic cross-section analysis tool is being applied to the upper-air data, to facilitate correlation with analyses of data from satellite imagery and the other sources.

Author

Atmospheric Refraction; Coasts; Lower Atmosphere; Mesoscale Phenomena; Refractivity; Spatial Distribution; Temporal Distribution; Variability

19960007256 Naval Air Warfare Center, Geophysics Div., Point Mugo, CA, United States

USE OF SATELLITE IMAGERY AND OTHER INDICATORS TO ASSESS VARIABILITY AND CLIMATOLOGY OF OCEANIC ELEVATED DUCTS

Helvey, Roger, Naval Air Warfare Center, USA; Rosenthal, Jay, Naval Air Warfare Center, USA; Eddington, Lee, Naval Air Warfare Center, USA; Greiman, Paul, Naval Air Warfare Center, USA; Fisk, Charles, Naval Air Warfare Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 14 p; In English; See also 19960007226; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Much of the world's ocean area is overlain by persistent elevated ducting due to a strong super-refractive gradient at the top of the marine layer. Several techniques are used to describe characteristics of the elevated duct on climatological, synoptic and local scales. In addition to statistical analysis of radiosonde databases, these techniques include subjective and objective applications of satellite imagery, computation of a duct height index from surface and upper level numerical analyses or forecasts, and various other indirect meteorological indicators of ducting. Refractive statistics from worldwide coastal, island and ship radiosonde profiles reveal a widespread diurnal variation in duct occurrence believed related to day-night changes in marine stratus/stratocumulus cloud amounts. Incorporation of this diurnal behavior, together with relationships found between elevated duct characteristics and conventional parameters suggest a basis for generation of improved worldwide oceanic elevated duct climatology from historical gridded surface upper-air analyses. The climatology world be in a gridded format, calibrated against climatological summaries from radiosondes to enable estimates of conditions for arbitrary locations, dates and times. Techniques for synoptic and mesoscale inference of elevated duct behavior are demonstrated using satellite imagery and synoptic indicators. Geostationary satellite imagery obtained during VOCAR in 1993-4 revealed synoptic and mesoscale cloud features depicting space/time variability over the eastern Pacific Ocean and adjacent coastal areas. The variability was related to large-scale air mass changes and weather systems; the development, dissipation and translation of coastal eddies in the marine layer; and diurnal land/sea breeze influences in the coastal zone.

Author

Atmospheric Refraction; Climatology; Coasts; Marine Meteorology; Meteorological Parameters; Oceans; Radiosondes; Refractivity; Satellite Imagery; Variability

19960007258 Naval Research Lab., Marine Meteorology Div., Monterey, CA, United States

MESOSCALE MODELING OF REFRACTIVE CONDITIONS IN A COMPLEX COASTAL ENVIRONMENT

Burk, Stephen D., Naval Research Lab., USA; Thompson, William T., Naval Research Lab., USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 7 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A mesoscale model was run in a data assimilation cycle throughout the 12-day period of the Variability of Coastal Atmospheric Refractivity (VOCAR) experiment's Intensive Observing Period (IOP). A developing synoptic low, a mesoscale eddy, sea-land breezes, mountain-valley winds, and coastal low-level jets (LLJ's) are some of the phenomena modeled, and to some extent, observed during VOCAR. Impacts of these processes on the marine atmospheric boundary layer (ABL) and microwave refractivity are highlighted in this paper. From August 23 to September 3, 1993 the IOP of the VOCAR

experiment was conducted in the Southern California bight from Point Conception to San Diego. This experiment was designed to observe the mesoscale structure of the ABL in the bight so as to accurately characterize the temporal and spatial variability of the microwave refractivity field. Analyses or forecasts of propagation conditions (e.g., surface-based or elevated trapping layers; exist of over-the-horizon propagation, etc.) require accurate depiction of the depth and structure of the ABL (particularly vertical gradients in temperature and moisture at the ABL top). Numerous special observations were made during the IOP and are used to elevate model performance.
Author
Air Water Interactions; Atmospheric Boundary Layer; Atmospheric Models; Atmospheric Refraction; Coasts; Mesoscale Phenomena; Refractivity; Variability

19960007259 Norwegian Meteorological Inst., Oslo, Norway
HIGH RESOLUTION METEOROLOGICAL GRID FOR CLEAR AIR PROPAGATION MODELING IN NORTHERN COASTAL REGIONS
Lystad, Sofus, Norwegian Meteorological Inst., Norway; Tjelta, Terje, Norwegian Telecom Research, Norway; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 13 p; In English; See also 19960007226; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Coastal area propagation and meteorological measurements have been studied along with atmospheric mesoscale modeling. Simultaneous propagation data from three consecutive links have been compared with measured and modeled meteorological data from a part of the Norwegian coast at about 65 deg latitude. The results show a close relationship between refractivity gradient, obtained by meteorological data, and multipath activity on the links. The mesoscale model does also give valuable information on the spatial and diurnal time dependency of refractivity gradients at the vicinity of ground as well as at various heights above the ground.
Author
Atmospheric Models; Atmospheric Refraction; Coasts; Marine Meteorology; Mesoscale Phenomena; Meteorological Parameters; Refractivity

19960007260 Swedish Air Force, Military Weather Service., Stockholm, Sweden
A MICROWAVE PROPAGATION MODEL COUPLED TO AN AIR MASS TRANSFORMATION MODEL
Grandin, G. E., Swedish Air Force, Sweden; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 5 p; In English; See also 19960007226; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Since 1985 a project in order to improve microwave propagation forecasts has been run in the Swedish Military Weather Service. The purpose has been to tests if there are computer-based models that are more useful than earlier manual methods. Until now two different kinds of models have been tested: The first one is a simple refractive index model for use onboard warships. The second kind of model is a refractive index model coupled to a one-dimensional boundary layer model connected to a horizontal trajectory in order to describe horizontal advection. The result is presented by ray tracing diagrams in order to give advice for tactical decisions at military aircrafts, warships and radar stations. Experiments with those two models have been made mainly over the Baltic Sea. During 1987-1992 the 'simple' model was tested onboard a warship. During the same period the other model was tested on nine sites in Sweden. There have been three 'intense' periods where extra efforts in personnel, measurements and verifications were made. The experiments showed that computer-based radar range forecasts are only usable in the Baltic Sea if: (1) there is input data with high quality; (2) the weather situation is homogeneous; and (3) the operators are educated.
Author
Air Masses; Atmospheric Refraction; Electromagnetic Wave Transmission; Forecasting; Microwaves; Ray Tracing; Refractivity

19960007261 Rutherford Appleton Lab., Radio Communications Research Unit., Chilton, United Kingdom
CLIMATIC MAPPING OF REFRACTIVITY PARAMETERS FROM RADIOSONDE DATA
Craig, K. H., Rutherford Appleton Lab., UK; Hayton, T. G., Rutherford Appleton Lab., UK; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 14 p; In English; See also 19960007226; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Global maps of super-refraction and duct statistics based on the analysis of radiosonde data have, for many years, been used to characterize the effects of climate in statistical radiowave propagation models. This paper describes a new analysis based on a more recent and more extensive dataset. The sources of radiosonde data and our data reduction and validation strategy are discussed, and the statistical parameters of interest for super-refracting and ducting layer statistics are introduced. Contour maps of these parameters are given for the European region; comparisons with earlier data highlight some of the problems involved in this type of study. Comparisons of high and low resolution data analyses for the coastal site of Hemsby in the UK are made, and the influence of the boundary layer on surface duct statistics discussed. Some conclusions are drawn on the usefulness of radiosonde data for the mapping of refractivity parameters.
Author
Atmospheric Boundary Layer; Atmospheric Refraction; Climate Models; Climatology; Marine Environments; Ocean Surface; Radio Transmission; Radiosondes; Refractivity

19960007262 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Physics and Electronics Lab., The Hague, Netherlands
IR/RF REFRACTIVITY PROFILES OVER COASTAL WATER
Deleeuw, Gerrit, Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Neele, Filip P., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Vaneijk, Alexander M. J., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 12 p; In English; See also 19960007226; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

In June 1992, IR/RF propagation experiments were conducted over the North Sea, at about 10 km SW from the German Island of Sylt. The experiments were a tri-lateral cooperation between institutes from Germany, Canada and The Netherlands, organized by the TNO Physics and Electronics Laboratory. The objective was a study on the complementarity of IR and radar detection systems. In this contribution we report on the characterization of the propagation environment by the TNO Physics and Electronics Laboratory. This includes aerosol and lidar measurements to determine the extinction properties throughout the marine atmospheric boundary layer, as well as measurements of humidity and temperature profiles in the marine atmospheric surface layer to determine refractivity profiles. Temperature and humidity profiles were measured from a jack-up barge 'Hubinsel Barbara' and on a mast. The sensors were mounted such that profiles could be measured from close to the sea surface, taking into account tidal effects and waves of 1.5 m, to height of 10 m on the mast and 35 m on the platform. The platform data are often perturbed. Therefore, in the analysis we focussed on the temperature and humidity profiles from the mast. Effects of sensor height, wind speed and thermal stratification were considered. Deviations from the logarithmic behavior have been observed. These are mainly ascribed to coastal influences, based on consideration of the height dependence and the effects of thermal stability. We conclude that in off-shore winds non-equilibrium situations often exist at the sensor locations, with an internal boundary layer that distorts the profiles.
Author
Aerosols; Air Water Interactions; Atmospheric Boundary Layer; Atmospheric Refraction; Coastal Water; Infrared Signatures; Meteorological Parameters; Radar Detection; Refractivity

19960016897 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
TACTICAL AEROSPACE C3I IN COMING YEARS *COMMANDES, PILOTAGE, COMMUNICATIONS, RENSEIGNEMENTS TACTIQUES AEROSPATIAUX DANS LES PROCHAINES ANNEES*
Oct. 1995; 214p; In English; In French; 3d Symposium, 15-18 May 1995, Lisbon, Portugal; See also 19960016898 through 19960016915 Report No.(s): AGARD-CP-557; ISBN 92-836-0019-3; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

This conference demonstrated that there are major C3I developments for the various international air forces underway, particularly in the USA (Theater Battle Management), in France (SCCOA), and at NATO (ACCS). These C3I systems (in effect, 'system systems') combine all the real time (surveillance, air mission control) and deferred functions (force planning and management) at a very high level of complexity. One of the problems has been how to organize,

manage, and control data flow between the complex elements of these systems. Tools are now being developed with this in mind. Another problem is that, although it is cost effective to use off-the-shelf components in the systems design, this process in itself creates a number of trade-off problems with regard to the system's conformity to specifications. The discussions and presentations of this conference were concerned with the following main issues: Requirements and trends in architecture; situation assessment; decision aids for planning, tasking, and execution, and techniques and technologies.
CASI
Surveillance Radar; Systems Engineering; Conferences; Command and Control; Architecture (Computers); Computer Systems Design; Mission Planning; Technological Forecasting; Systems Management; Decision Making; Computer Systems Programs; Radar Tracking; Military Operations

19960016898 Services Technique des Telecommunications et des Equipements Aeronautiques, Paris, France
SCCOA (AIR OPERATION CONDUCT AND CONTROL SYSTEM) PROGRAM: AIR FORCE REQUIREMENTS AND ITS TECHNICAL DEVELOPMENT ***LE PROGRAMME SCCOA: LE BESOIN DE L'ARMEE DE L'AIR ET SON DEVELOPPEMENT TECHNIQUE***
Naville, Services Technique des Telecommunications et des Equipements Aeronautiques, France; Oct. 1995; 18p; In French; See also 19960016897; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The decision to create such a program for SCCOA was made on February 15, 1989. The author discusses the rationale for the creation and growth of the program. The article emphasizes the advantages of having an open and evolving system. Mentioned are the new specific requirements for the future of aviation command and control systems (installation of 23 cm radar units for civil aviation; high frequency over the horizon radars for the S and L bands, particularly for small radar cross section targets; and an AWACS system for low altitude targets). A systems approach will be required for the detection area in order to achieve better radar coverage and operation in emergencies. Data produced by the detection equipment will be transmitted to the control and command center of the aviation operations.
Transl. by Schreiber
Command and Control; Decision Making; Surveillance Radar; France; Project Management; Military Operations; Ground Support Equipment; Radar Networks; Systems Engineering

19960016899 Services Technique des Telecommunications et des Equipements Aeronautiques, Paris, France
LONGTERM ASPECTS OF AIR FORCE C3I ***ASPECTS PROSPECTIFS DES C3I AIR***
Desnoees, Services Technique des Telecommunications et des Equipements Aeronautiques, France; Oct. 1995; 4p; In French; See also 19960016897; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

This article discusses the longterm aspects of command, communications, and control as they relate to Air Force strategic planning. The author begins by discussing the different characteristics of the present programs including the following: the growing significance of software in major systems; the evolution of software packages rather than fundamental growth; the fact that after the current programs have been completely computerized that there will be only minor additions and changes as required to these systems; the fact that there are approximately thirty different systems that can be identified which must be able to operate with one another; and that the equipment,the software, and the interfaces between the various softwares for these systems are becoming increasingly standardized. The author then analyzes future trends ten to twenty years beyond the time period covered by the present programs.
Transl. by Schreiber
Military Operations; Command and Control; Management Planning; Technological Forecasting; Surveillance Radar; Radar Equipment; Technology Assessment; France

19960016900 Aerospatiale, Espace and Defense Div., Les Mureaux, France
AIR FORCE C3I ARCHITECTURE CONCEPTS
Crochet, M., Aerospatiale, France; Oct. 1995; 4p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The purpose of this paper is to discuss architectural concepts as they apply to a system, of which the complexity is more than simply the addition or the connection of susbsystems. This the way that the large C3I systems for the Air Defence and Air Operations must be designed, since the systems control a large set of planning, tasking, mission preparation, mission control, intelligence, and communications that overlap in this complex set of a 'System of Systems.' This article discussed the SCCOA environment, new functions (concepts) in SCCOA, the architecture, the architects, those people involved in the development and use of the system, the tools used in developing the architecture, and the management of the system.
Derived from text
Air Defense; Radar Equipment; Complex Systems; Management Systems; Surveillance Radar; Computer Systems Design; Military Operations; France

19960016901 Mitre Corp., Bedford, MA United States
A TECHNICAL MANAGEMENT STRUCTURE FOR THE EVOLUTION OF TACTICAL AEROSPACE C3I SYSTEMS
McCay, Brian M., Mitre Corp., USA; Oct. 1995; 10p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A technical management structure using Model-Based Systems Engineering (MBSE) concepts and implemented via an integrated suite of tools is recommended to manage the evolution of tactical aerospace C3I systems. A system-of-systems (S2) engineering perspective is advocated to identify processes, methods, and tools that support the capture, analysis, and management of these systems. An integrated systems engineering environment (ISEE) is introduced as the mechanism used to capture, store, and generate the information necessary to manage change across tactical aerospace C3I systems. Work currently being performed to manage change of the Air Warning Mission C3I systems within the Integrated Tactical Warning/Attack Assessment (Integrated TW/AA) S2 is discussed to show how MBSE concepts are currently being used. Extensions of this work are presented in terms of an evolving tactical aerospace C3I systems architecture and the inclusion of other tools. Finally, advances in enabling technologies, methods, and tools are mentioned to suggest directions of how to fully develop a tactical aerospace C3I systems ISEE.
Author
Aerospace Systems; Architecture (Computers); Systems Engineering; Warning Systems; Management Systems; Computer Systems Design; Surveillance Radar

19960016902 Department of the Air Force, Architectures, Technology, and Interoperability Directorate., Washington, DC United States
HORIZON: AN ARCHITECTURE MANAGEMENT AND C4I CAPABILITIES PLANNING PROCESS FOR THE UNITED STATES AIR FORCE
Cookerly, David H., Department of the Air Force, USA; Buckley, David I., Mitre Corp., USA; Boyle, Eugene J., Jr., Mitre Corp., USA; Oct. 1995; 16p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A methodology for managing Command, Control, Communications, Computers, and Intelligence (C4I) interoperability problems in a multi-mission environment is presented. The effort, designated Horizon, was sponsored by the USA Air Force (USAF). It is a disciplined top down process for managing and directing architectures starting at a high level. The essential elements of interoperability are defined. Mission operations boundaries are formulated to serve as a framework for construction of top level and mission level views of the C4I elements. Information flow between C4I elements is described, and the combination fo the views and the interoperability attributes are organized into a database. Commercial-off-the-Shelf (COTS) software was used to develop a tool, designated Horizon Link, to support the process. The database may be expanded to accommodate specific user needs and to support specialized analyses. The use of the database to support specialized analyses. The use of the database to support a communications systems analysis within the framework of the defined C4I interoperability model is described.
Derived from text
Command and Control; Support Systems; Management Systems; Architecture (Computers); Computer Networks; Project Planning; Management Planning; Military Operations; Military Technology

19960016904 Societe d'Applications Generales d'Electricite et de Mechanique, Eragny sur Oise, France
SECURITY OF COMMAND SYSTEMS *LA SECURISATION DES SYSTEMES DE COMMANDEMENT*
Velu, Jean-Pierre, Societe d'Applications Generales d'Electricite et de Mechanique, France; Oct. 1995; 8p; In French; See also 19960016897; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The security of command information and communication systems is a necessity because these systems must fully and exactly carry out the mission entrusted to them. Many examples have shown that when security is neglected, the risks incurred could be catastropic, especially in a crisis. The sensitive information involved in these situations is stored in the databases of these interconnected systems. Consequently, an attack on one of the interoperable SIC network units could be harmful to the entire group of systems and could even, in the worst case, paralyze the entire network. The defense against such attacks consists of controlling access to the sensitive data, as automatically as possible. In other words, surveillance over the subjects and objects of security must be carried out in conformity with a previously established discipline, 'the security policy', of the system in question. This security policy, which must be tested for certain assurance levels for implementation, is prioritized in terms of the security required for: computer retrieval that pertains to data access; data transmissions; and physical access. Dealing with all of these aspects exceeds the scope of the present presentation, in such, that we will limit our discussion to the examination of the typical situations that are often encountered in the integration of commercial products, the restoration of systems, and the interoperability of the SIC systems. Although we will not examine multi-level use systems, we will discuss the security of databases and the identification/authorization process, which are two essential points of security.
Transl. by Schreiber
Command Guidance; Information Systems; Computer Information Security; Warning Systems; Data Bases; Management Systems; Information Management; Surveillance

19960016907 Thomson-CSF, SDC Div., Bagneux, France
APPLICATIONS OF MULTISENSOR DATA FUSION TO TARGET RECOGNITION
Moruzzis, Michel, Thomson-CSF, France; Colin, Nathalie, Thomson-CSF, France; Milhem, Gilbert, Thomson-CSF, France; Oct. 1995; 10p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Target Recognition, which is a key function for ensuring the successful execution of conflicts and wars, will be based on multisensor data fusion. The objective of this paper is to highlight some aspects of multisensor data fusion applied to target recognition in the aim of defining an operational system. This paper gives a description of a multisensor system and the processing architecture which can be used for simultaneous target recognition and tracking. Basic fusion techniques, such as Bayesian Inference, Evidence Theory, and Fuzzy Logic, are then introduced with some practical results presented to illustrate these techniques. A data processing architecture, which includes both tracking and recognition functions, is presented and the respective merits of the conventional techniques are discussed in regards to the different processing functions.
Author
Multisensor Fusion; Target Recognition; Technology Utilization; Fuzzy Systems; Bayes Theorem; Inference; Radar Tracking; Surveillance Radar

19960016908 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Physics and Electronics Lab., The Hague, Netherlands
DISTANCE BASED RANGE PROFILE CLASSIFICATION TECHNIQUES FOR AIRCRAFT RECOGNITION BY RADAR: A COMPARISON ON REAL RADAR DATA
vanderHeiden, R., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Groen, F. C. A., Amsterdam Univ., Netherlands; Oct. 1995; 8p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Aircraft identification is essential in any air-defense scenario. Without a robust classification capability, no effective threat evaluation can be performed. A prominent aircraft recognition technique is based on the exploitation of a one-dimensional image of a target, a range, profile. In this paper, we employ four different classification techniques, all based on shift invariant distances, and a method to compare them. Two of the techniques are based on Radial Basis Functions for which a novel technique to optimize the number of free parameters is presented. The application is one real radar data, where a true separation between train and test profiles is accomplished. The classification results are encouraging. As an example, a qualitative statement is given about the best of the four classifiers to be used in combinations of two scenarios and four applications.
Author
Radar Signatures; Surveillance Radar; Radar Data; Target Recognition; Image Classification; Rangefinding; Imaging Techniques

19960016909 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Physics and Electronics Lab., The Hague, Netherlands
DECISION TOOL FOR OPTIMAL DEPLOYMENT OF RADAR SYSTEMS
Vogel, M. H., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Oct. 1995; 4p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

A Decision Tool for air defense is presented. This Decision Tool, when provided with information about the radar, the environment, and the expected class of targets, informs the radar operator about detection probabilities. This assists the radar operator in selecting the optimum radar parameters. This newly developed computer program, PARADE, is presented along with its future applications for use with radar operator parameter selection.
Author
Air Defense; Surveillance Radar; Applications Programs (Computers); Computer Aided Mapping; Artificial Intelligence; Decision Making; Radar Tracking; Aircraft Detection; Probability Theory

19960016913 Alenia Spazio S.p.A., Rome, Italy
MULTIPLE HYPOTHESIS TRACKING VERSUS KALMAN FILTER WITH NEAREST NEIGHBOR CORRELATION. PERFORMANCE COMPARISON
Graziano, A., Alenia Spazio S.p.A., Italy; Miglioli, R., Alenia Spazio S.p.A., Italy; Farina, A., Alenia Spazio S.p.A., Italy; Oct. 1995; 12p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Multi-target tracking systems in operational use today generally adopt standard Kalman filter techniques, coupled with a maneuver detector to introduce some kind of adaptivity, and nearest neighbor (NN) correlation with a plethora of heuristics to improve the performance of the system. through Monte Carlo simulations, the performance of a multiple hypothesis multi-target tracking algorithm were evaluated in the terms of the probability of correct association of a track to a target. The performance of a Kalman filter plus NN issued as reference. Results are presented for a number of study cases related to several operational situations of interest (e.g. up to eight targets undergoing maneuvers). A preliminary evaluation of the processing time ensures that the MHT algorithm can be implemented in modern computers having adequate processing power.
Derived from text
Hypotheses; Tracking Filters; Kalman Filters; Algorithms; Multiple Target Tracking; Probability Theory; Heuristic Methods

19960016915 Mitre Corp., Bedford, MA United States
LARGE SCALE LINK 16/JTIDS NETWORKS
Barto, J. L., Mitre Corp., USA; Oct. 1995; 4p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The JTIDS Joint Program Office (JPO) has been on the leading edge of the large scale multi-service, multi-platform, multi-mission JTIDS network design for several years. Large scale network design studies conducted by the JPO have shown that if JTIDS is used efficiently and appropriately, it can meet expanding user and functional requirements, including multi-national operations. However, increasing reliance on JTIDS for theater communications will require a continued effort to develop more efficient says to use it.
Derived from text
Computer Networks; Computer Systems Design; Large Scale Integration; Design Analysis; Network Analysis; Weapon Systems; Military Operations; Time Division Multiple Access; Architecture (Computers)

19960022241 Advisory Group for Aerospace Research and Development, Sensor and Propagation Panel, Neuilly-Sur-Seine, France
ENVIRONMENTAL FACTORS IN ELECTRONIC WARFARE RELATED TO AEROSPACE SYSTEMS *LES FACTEURS D'ENVIRONNEMENT EN GUERRE ELECTRONIQUE RELATIFS AUX SYSTEMES AEROSPATIAUX*
Jan. 1996; 150p; In English; Sensor and Propagation Panel Symposium, 8-11 May 1995, Pratica di Mare AFB, Rome, Italy; See also 19960022242 through 19960022254
Report No.(s): AGARD-CP-573; ISBN 92-836-1028-8; Copyright Waived; Avail: CASI; A07, Hardcopy; A02, Microfiche

An in-depth knowledge of the characteristics of the propagation medium and how they should/could be modified is essential in order to obtain more efficient sensors for aerospace systems. During the symposium the effects of environmental factors on the different disciplines relating to EW were widely analyzed, and all relevant aspects were considered including among others: the effect of interference in the ionosphere on various satellite systems, and the propagation mechanisms affecting countermeasures against EO and laser systems; the layering of appropriate paints as a means of protecting airbase structures in more than one band, as well as camouflage as a measure against radar sensors; and the disruptive potential of high-power microwaves, and the exploitation of SMART munitions. Considering the problem of reduction of aircraft signature, evidence was provided that it is not possible to achieve this by an accurate definition of the mission profile. Finally, several solutions were offered to protect aircraft during peace-keeping operations, i.e. an active self protection laser system against optical seeker head missiles.
Author
Aerospace Systems; Electronic Warfare; Microwaves; Laser Applications

19960022242 Cranfield Univ., School of Electrical Engineering and Science., Shrivenham, United Kingdom
FUTURE MILITARY ELECTRONIC WARFARE: WHERE WILL MODERN SIGNAL PROCESSING TAKE US?
Hill, Peter C. J., Cranfield Univ., UK; Saull, Ray C., Cranfield Univ., UK; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 10p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Military electronic warfare (EW) is well recognized as a facilitating force multiplier in deciding the outcome of a conflict situation. Its operation depends very largely now on smart electronic signal processing. Modern developments in the fields of digital signal processing (DSP) algorithms, devices and systems and also in processing optical signals have been fast and a number of novel paradigms have emerged which will possibly have important repercussions in the EW arena. Selected cases are described together with research examples to show the progress and applicability of the new techniques. The main purpose of the paper is to focus on those hot signal processing developments which the EW community should be encouraged to monitor very closely.
Author
Electronic Warfare; Military Technology; Electronic Countermeasures

19960022243 Phillips Lab., Ionospheric Effects Div., Hanscom AFB, MA United States
THE IONOSPHERIC FACTOR: EFFECTS AND MITIGATION IN RF NAVIGATION, SURVEILLANCE AND COMMUNICATION
Bishop, Gregory J., Phillips Lab., USA; Mazzella, Andrew J., Northwest Research Associates, Inc., USA; Holland, Elizabeth A., Northwest Research Associates, Inc., USA; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 12p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The ionosphere is a factor in all RF systems that involve links between ground/air and space at or above 100 km altitude, and frequencies up to at least 4 GHz. Ionospheric scintillation can cause message errors in satellite communication links and reduced availability of satellites for GPS navigation. Ionospheric range errors can result in loss of accuracy or resolution in surveillance from space, or ground-based surveillance of space objects. The determination of whether the ionosphere will generate significant system degradation involves both environmental and system parameters. Environmental parameters include: earth-space weather, time of day, season, time of the solar activity cycle, and region of operation. System parameters include: frequency, noise thresholds, and performance requirements such as accuracy, resolution, or data rate. Mitigation, if possible, must be adapted to the function and specific mission of the aerospace system. Two-frequency GPS navigation incorporates ionospheric measurement for range error mitigation. However, single-frequency GPS must depend on statistical models or adjunct differential techniques. Ionospheric scintillation, through loss of lock, or reduced signal margins, can reduce availability of satellites for maintaining GPS navigation integrity. GPS navigation systems can be designed to monitor signal quality and employ adjunct inertial systems over intervals when GPS availability is compromised. In communication, for some systems, special equipment and signal formats can reduce message errors. Local measurement-warning systems can also be used to monitor onset and location of ionospheric disturbances, and identify satellite links that remain clear. When linked to a scintillation model, such warning systems can provide regional capability to identify 'windows' for good operation of both surveillance and communication. Similarly, measuring systems that monitor ionospheric range error may be linked to region-adapted ionospheric models for surveillance correction. For systems with a wider mission, corrections outside the reach of a local monitor are required. These may be obtained from global networks of ionospheric sensors providing real-time input to global ionosphere and space weather models.
Author
Ionospheric Disturbances; Aerospace Systems; Earth Ionosphere; Surveillance; Scintillation; Satellite Networks; Noise Threshold

19960022244 Siemens-Plessey Systems, Somerford, United Kingdom
ADAPTIVE INTERFERENCE CANCELLATION AS A MEANS OF COPING WITH THE COMPLEXITY OF THE TARGET ARRAY AND THE PLATFORM ENVIRONMENT IN MODERN AND FUTURE COMMUNICATIONS ELECTRONIC WARFARE SYSTEMS
Horner, R., Siemens-Plessey Systems, UK; Thwaites, D. R., Siemens-Plessey Systems, UK; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 10p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The basic principle of adaptive interference cancellation is very simple, it is the removal of an unwanted interfering signal by algebraically adding a replica of the unwanted component which has precisely the same amplitude a opposite phase. This paper introduces the techniques of adaptive interference cancellation and describes a practical solution fielded with a major tactical system.
Derived from text
Electronic Warfare; Aerospace Systems; Satellite Tracking; Interference; Communication Satellites

19960022245 MAZ Hamburg G.m.b.H., Hamburg, Germany
PREDICTION OF ANTENNA TO ANTENNA COUPLING BY USE OF A COMPUTER PROGRAM, BASED ON THE METHOD OF MOMENTS
Klook, Th., MAZ Hamburg G.m.b.H., Germany; Gonschorek, K.-H., Technische Univ., Germany; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 8p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

On complex systems like vessels, vehicles, planes and rockets often there are used closely spaced antennas. When planning the electromagnetic compatibility of such systems the question for possible interactions between transmitting and/or receiving equipment is a major problem. It has to be clarified how critical the coupling between closely spaced antennas will be, including the question of how the antenna pattern will be influenced. The simultaneous operation of two antennas is a very serious problem if the difference of the operation frequencies is very small. The coupling of power from one transmitter to the other (active influence) may produce malfunctions or damage the output stages. The possible detuning of the neighboring antenna (passive influence) is a further problem to be paid attention to. With the help of efficient software it is possible to carry out an effective planning of the electromagnetic compatibility of such kind of systems and to support the selection of suitable antenna locations.

The computation of different cases of influences will be described, with the help of the computer program CONCEPT, which is based on the method of moments (MoM).
Author
Antenna Couplers; Computer Programs; Electromagnetic Compatibility; Method of Moments

19960022246 Forschungsinstitut fuer Hochfrequenzphysik, Werthhoven, Germany
TRENDS AND TENDENCIES IN LPI RADAR
Kuschel, Heiner, Forschungsinstitut fuer Hochfrequenzphysik, Germany; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 10p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

To achieve a Low Probability of Intercept is one of the most vital interests of radar developers. Different approaches to LPI radars have been made and some existing concepts are presented. The principle capabilities of LPI radar concepts are discussed and future trends are analyzed with respect to ESM-system development and growing signal processing potentials.
Author
Radar; Signal Processing; Probability Theory; Radar Signatures; Missile Detection; Electronic Warfare

19960022247 Wehrwissenschaftliches Inst. fuer Schutztztechnologien - ABC-Schutz, Munster, Germany
MODELLING OF GUIDED MISSILES AND NUMERICAL SIMULATION OF THEIR INTERACTION WITH RF WAVES
Nitsch, Juergen, Wehrwissenschaftliches Inst. fuer Schutztztechnologien - ABC-Schutz, Germany; Vogel, Hans-Joachim, Wehrwissenschaftliches Inst. fuer Schutztztechnologien - ABC-Schutz, Germany; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 10p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

RF coupling into guided missiles is described on the basis of rough analytical estimates and of the application of the numerical MoM code CONCEPT. Coupling is maximized by resonant excitation in the external and internal resonance region of the missile and mainly takes place via slots in the surface of the missile and via the fins and stabilizers which act as antennas. In the senses of norms (infinity-(peak) and 2-norm (i.e. - square root of energy)) a damped sinusoidal waveform in general produces a response which is much larger than that due to a decaying exponential waveform.
Author
Electronic Warfare; Waveforms; Missiles; Digital Simulation; Electromagnetic Coupling

19960022248 Diehl G.m.b.H. und Co., Dept. M-ELK., Roethenbach, Germany
EXPERIMENTAL HPM SUSCEPTIBILITY, EXPLOITATION OF SMART MUNITIONS
Bohl, J., Diehl G.m.b.H. und Co., Germany; Kaiser, A., Wehrwissenschaftliches Inst. fuer Schutztztechnologien - ABC-Schutz, Germany; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 16p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Direct experimental exploitation and investigation of smart munitions are necessary to determine and analyze the coupling mechanisms from an outside electromagnetic field to the inside of the smart munitions where it can interact with the electronical guidance and control components as well as with the wiring. This interaction can lead to upsets on critical signals or/and to resonances on the signals. Numerical and analytical investigations are conducted prior to the experimental irradiation tests. For first approaches, direct injections of currents (normalized to the outer electric field) at the potential coupling paths (apertures and antennas) are applied to measure the resonances transferred to the inside of the munition. These test results are used as a basis for experimental exploitations at the live system with a defined simulated flight condition exposed to an electromagnetic field. The important point here is that not all coupled resonances cause a reaction/degradation in the guidance and control loops of the complex systems.
Author
Weapons; Guidance (Motion); Electromagnetic Fields; Digital Simulation; Resonance

19960022251 Phillips Lab., Hanscom AFB, MA United States
TURBULENCE IN THE UPPER ATMOSPHERE: EFFECTS ON SYSTEMS
Basu, Santimay, Phillips Lab., USA; Bishop, Gregory J., Phillips Lab., USA; Larson, John, Space Command, USA; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 10p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The F-region of the ionosphere typically above 150 km at times becomes turbulent and develops small scale (less than 1 km) irregularities of electron density. These irregularities scatter radio waves from satellites in the VHF and UHF range and generate amplitude and phase scintillation. The magnitude of scintillation decreases with an increase of frequency but may be of concern at frequencies as high as 10 GHz. Scintillations are pronounced at equatorial and polar latitudes. The most severe scintillation is recorded over two belts, a few degrees wide at approximately 15 deg north and 15 deg south of the magnetic equator. The stations at Ascension Island, Diego Garcia, Hong Kong and Taiwan are located in this region where satellite communication links at 1.5 GHz may suffer 20 dB fades after sunset during the solar maximum period. The transmissions of GPS satellites at 1.228 GHz and 1.575 GHz are thus vulnerable. Scintillations cause message errors, cycle slips and loss of phase lock in satellite communication and navigation systems. In this paper, we first provide a summary of the climatology of scintillation with emphasis on the effects of scintillation on space systems. While the climatology of scintillation is fairly well established, the specification and forecasting of scintillation on a daily basis remains a challenging problem in view of the extreme day-to-day variability of scintillation, which is unfortunately most pronounced in the severely disturbed equatorial region. Attention is focused on this shortfall in the context of the recently formulated U.S. National Space Weather Program (NSWP) requiring the nowcasting and forecasting of the conditions on the sun, and in the solar wind, magnetosphere, ionosphere and thermosphere.
Author
Upper Atmosphere; Turbulence; Scintillation; F Region; Satellite Communication; Navigation Satellites; Global Positioning System; Communication Networks; Solar Activity Effects

19960022253 Edgewood Research Development and Engineering Center, Aberdeen Proving Ground, MD United States
ACCURACY OF COMPUTER CODES THAT CALCULATE ELECTROMAGNETIC CROSS SECTIONS OF NONSPHERICAL PARTICLES
Embury, J. F., Edgewood Research Development and Engineering Center, USA; Rainey, J. D., Edgewood Research Development and Engineering Center, USA; Sindoni, O. I., Edgewood Research Development and Engineering Center, USA; Jan. 1996; 6p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Accuracy of the electromagnetic cross sections of spheroidal particles computed using the discrete dipole approximation and the extended boundary condition method are checked in the high and low frequency limits and in the limit where the shape becomes spherical. We compute electromagnetic cross sections and intensity scattering matrix elements of spheroids with aspect ratios (major to minor axis ratios) up to four averaged over random orientations for a range of sizes where the major and minor axes are much greater than the wavelength and much less than the wave length. Complex refractive indices typical of dielectric material in the visible and infrared spectral regions have been chosen. Accuracy is judged based on comparisons with Mie theory calculations in the limit when aspect ratio approaches unity, with the Rayleigh spheroid theory in the limit when both size parameter and phase shifts are small, with the geometric optics theory in the limit when both size parameter and phase shifts are large, and finally in the anomalous diffraction theory in the limit of large size parameter and

complex refractive index near unity. In addition we use constraint inequalities involving the intensity scattering matrix elements to check the validity of randomly oriented spheroid calculations.
Author
Electromagnetic Fields; Applications Programs (Computers); Accuracy; Mie Scattering; Scattering Cross Sections; Spheroids

19960022254 British Aerospace Defence Ltd., Military Aircraft Div., Warton, United Kingdom
ENVIRONMENT MODELS AND THREAT SIMULATORS: HIGH QUALITY AND LOWER COST VALIDATION OF EW SYSTEMS
Pywell, M., British Aerospace Defence Ltd., UK; Stubley, N., British Aerospace Defence Ltd., UK; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 12p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Recent conflicts such as the Falklands campaign, Gulf conflict and Bosnia have amply demonstrated the importance of EW to Mission Effectiveness and crew. Survivability. In addition to this, since world-wide defence budgets are still reducing overall, the key driver for most Customers is Affordability. to a major aircraft prime contractor such as BAe Defence, these Customer requirements mean addressing a number of issues related to establishing the minimum necessary aircraft EW suite to satisfy those requirements. A key issue in this determination is a precise definition of the radar, RF and Electro-Optic (EO) electromagnetic environment that the aircraft must operate correctly in. This paper addresses this aspect and the tools and techniques necessary to produce aircraft EW systems that not only conform to specification, i.e. have no defects, but also have adequate performance, i.e. are 'fit for purpose'. It concentrates on the RF environment (modelling amd threat simulators) as relevant to the testing of ESM/RWR/ELINT amd ECM systems, although the principles are equally applicable to the EO, i.e. Infra-Red (IR) and Ultra-Violet (UV) regimes, and this is also discussed. It outlines EW System specification, describes EW environment modelling and its role in the design and validation process, covers EW Test and Evaluation (T&E) improvements, identifies shortfalls in current modelling capabilities, and gives major thrusts aimed at improving the EW development process. It addresses the issues above in the light of BAe Defence, Military Aircraft Division's experience in the field of both RF scenario modelling in support of a number of aircraft projects and planned ESM-ECM development work using scenario and equipment modelling, two world-class RF threat simulators, state-of-the-art ECM response measurement equipment and EW data analysis tools. It develops the argument that one of the main contributors to previous/current poor press on EW systems is believed to be the lack of adequate EW scenario definition at equipment/aircraft contract signature and that such definition should appear in specifications along side electromagnetic compatibility and other environmental issues.
Author
Environment Simulators; Environment Models; Evaluation; Aircraft Design; Tests

19960053048 Daimler-Benz Aerospace A.G., Airborne Systems Div., Ulm, Germany
MULTIFUNCTION MILLIMETRE WAVE RADAR FOR FUTURE MILITARY NAVIGATION
Roschmann, H. J., Daimler-Benz Aerospace A.G., Germany; Tospann, F. J., Daimler-Benz Aerospace A.G., Germany; Jun. 1996; 10p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

In future military transport aircraft or helicopters, the crew must be assisted under bad weather conditions to solve specific operational problems such as runway detection, landing, low level flight, ground mapping, and ground movement. Some of these applications can also be applied to unmanned aircraft. To provide these new functions, and enhanced vision system (EVS) is proposed. System and functional requirements for a millimeter wave radar proposed for the EVS are discussed in this paper.
Derived from text
Enhanced Vision; Functional Design Specifications; Aircraft Maneuvers; Synthetic Aperture Radar; Algorithms; Radar Imagery; Aircraft Landing

19960053053 Thomson-CSF, Elancourt, France
AUTOMATIC LOCALIZATION OF TARGETS FROM A RADAR CARD *LOCALISATION AUTOMATIQUE D'OBJECTIFS A PARTIR D'UNE CARTE RADAR*
Mestre, J. P., Thomson-CSF, France; dePeufeilhoux, R., Thomson-CSF, France; Jun. 1996; 10p; In French; See also 19960053042; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

A ground attack mission requires,in general, several target acquisition stages for the purpose of navigation (in order to calculate the aircraft position) or attack (in order to designate the target to be processed). Forward point radar is one technique that can be used for these acquisitions. Localization of a target can be achieved from the synthetic aperture radar (SAR) cards which are acquired during a mission by the radar. The localization procedure used can be manual (pilot designated on he card) or automatic (system proposed solution). This paper presents the principle methods employed to achieve this function as well as the main lines adhered to by Thomson-CSF.
Author
Synthetic Aperture Radar; Target Acquisition; Air to Surface Missiles; Global Positioning System; Position (Location); Automation

19970000233 Advisory Group for Aerospace Research and Development, Sensor and Propagation Panel, Neuilly-Sur-Seine, France
DIGITAL COMMUNICATIONS SYSTEMS: PROPAGATION EFFECTS, TECHNICAL SOLUTIONS, SYSTEMS DESIGN *SYSTEMES DE PROPAGATION NUMERIQUES: EFFETS DE LA PROPAGATION, SOLUTIONS TECHNIQUES, CONCEPTION DES SYSTEMES*
Apr. 1996; 484p; In English; In French; Sensor and Propagation Panel Symposium, 18-21 Sep. 1995, Athens, Greece; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19970000234 through 19970000282
Report No.(s): AGARD-CP-574; ISBN 92-836-0023-1; Copyright Waived; Avail: CASI; A21, Hardcopy; A04, Microfiche

This publication contains the unclassified papers presented at a specialists' meeting sponsored by the Sensor and Propagation Panel of AGARD. The topics covered included: Limitations imposed by propagation on digital communications systems. All frequency bands; Recent advances in propagation evaluation and in propagation models; Simulation of communication channels; Signal processing methods for digital communication systems; Data digital communication systems: urban zones, satellites, networks, adaptive systems; New concepts for systems design.
Derived from text
Conferences; Solutions; Wave Propagation; Systems Engineering; Data Transmission

19970000234 Hellenic Air Force Academy, Air Tactics Center, Athens, Greece
FLOW OF INFORMATION IN FUTURE AIR WAR
Heliotis, D., Hellenic Air Force Academy, Greece; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 18p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Despite today's advantageous technological infrastructure, the amount of messages to and from various departments of the modern armed forces, have multiplied by such a factor, that they threaten to fill up the capacity of the existing communication systems. A more serious concern is the number of people required to execute or take some action on them. An intelligent information collection system should be able to manage with the coordinated employment of various types of sensors as well as with other information sources and to deal in real time with the collected data in order to provide the users at each level with secure, detailed and reliable information. The information should cover all aspects and factors concerning the development of the battle, i.e. from the enemy forces to the atmospheric conditions. Furthermore, one of the most important operational requirements is that the correlation, processing and distribution of data and information should concern all the interested centers and command posts wherever they operate. An intelligent information collection system should provide a global picture of the battlefield in real-time to allow the performance of the command and control functions. There is a clear requirement for computer-based data fusion aids to assist the officer in understanding what is happening. Underlying the whole data fusion process is the necessity of the human-computer interaction. Beyond the man-machine interface, interfacing with the inference system must be

possible. The incoming information that requires processing and its corresponding systems should be designed to operate in a very dense and complex EM environment in order to perform automatic enemy radar detection, analysis, identification, and very accurate localization. The incorporation of one or more expert systems is a key element in this processing. A distribution information system should comprise personnel, equipment, facilities and communications to provide authorities at all levels with adequate data to plan, direct, coordinate and control conventional air operations. The command and control activities supported by a distribution information system, for which the information exchange is essential, are: force management, command and control resource management, airspace management, surveillance, air mission control, and air traffic control.
Derived from text
Data Acquisition; Data Management; Computer Techniques; Human-Computer Interface; Data Processing

19970000235 Defence Research Agency, Radio Science and Propagation Group, Malvern, United Kingdom
AN ANALYTIC RAY TRACING MODEL FOR HF IONOSPHERIC PROPAGATION
Norman, Robert J., Defence Research Agency, UK; Platt, Ian G., Defence Research Agency, UK; Cannon, Paul S., Defence Research Agency, UK; Apr. 1996; 10p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The analytic ray tracing model described here is a near realtime ionospheric model which includes an approximation to the ionospheric profile which allows the inclusion of horizontal gradients. The results in this paper are encouraging, especially when we compare the propagation results when using the analytic ray tracing model with the numerical ray tracing, which traces through the synthesized ionospheric profile produced using the FAIM model. The percentage difference in the resultant ground range between the numerical ray tracing and the analytic ray tracing model described here is only 2.9%. Even less difference would be observed using smaller steps in grid size and using more grid layers. This will be investigated in a later paper. The analytic ray tracing model produces a fast approximation to the entire propagation footprint. In fact the analytic ray tracing technique described here together with the tilting method is more than 10 times faster than the numerical ray tracing package. Higher resolution regions of the footprint will still need to rely on, the slower, numerical ray tracing techniques. Thus, it is more than likely, in any particular application, that a propagation footprint may require a combination of both the analytic ray tracing model and numerical ray tracing techniques.
Derived from text
Ray Tracing; Ionospheric Propagation; Mathematical Models

19970000236 Norwegian Defence Research Establishment, Kjeller, Norway
AN IMPROVED MODEL OF IONOSPHERIC ABSORPTION AT HF HIGH LATITUDE PATHS
Jodalen, V., Norwegian Defence Research Establishment, Norway; Thrane, E. V., Norwegian Defence Research Establishment, Norway; Apr. 1996; 12p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The performance of current HF prediction programs at high latitudes is often poor due to a lack of observations at these latitudes, but also because of incomplete understanding of the complex processes occurring in the ionosphere. Earlier work have shown that the prediction of signal strength and propagation using IONCAP/ICEPAC is too optimistic at high latitudes. This work introduces into ICEPAC a new model of electron densities in the high latitude D-region developed by Friedrich and Torkar, 1983. The model uses a statistical analysis to relate electron density profiles (60-120 km) to time of day and measured riometer absorption. We suggest that ionospheric loss on oblique incidence skywave paths be calculated in ICEPAC by integrating through the model using the Appleton-Hartree equation. Further we implement mode availability as an independent statistical factor to be multiplied with the probability of achieving a certain signal to-noise ratio. The new predictions are compared with HF measurements on a high-latitude path within Norway. The modifications have improved the agreement between data and predictions, particularly for disturbed geomagnetic conditions. For example, the observed diurnal variation of absorption is now reflected in the predictions.
Derived from text
Ionospheric Propagation; Latitude; High Frequencies; Signal Analysis; Signal Reception

19970000237 Army Communications-Electronics Command, Space and Terrestrial Communications Directorate, Fort Monmouth, NJ United States
PASSIVE HF PROPAGATION EVALUATION TECHNIQUE
Soicher, Haim, Army Communications-Electronics Command, USA; Houminer, Zwi, Technion - Israel Inst. of Tech., Israel; Apr. 1996; 8p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Reliable communications among mobile as well as fixed HF skywave nodes along short, medium and long-range paths require propagation assessment. Such assessment could be facilitated with the monitoring of ionospheric characteristics by continuously available passive means i.e., measurement of the Total Electron Content (TEC) using satellite-emitted signals without a need for burdening the electromagnetic spectrum. With the availability of the ubiquitous Global Positioning System (GPS) to provide instantaneous time-delay, or equivalently TEC, values when needed, an assessment of HF propagation conditions may be available on a near-real-time basis. Both TEC and the peak electron density of the ionosphere, which determines the ordinary upper frequency limit (f(sub 0)F(exp 2)) for HF skywave vertical propagation, vary strongly with solar and geomagnetic parameters. Their ratio, the equivalent slab thickness, may vary to a much lesser degree and as such may be modeled with greater accuracy. A slab thickness model combined with real-time TEC measurement anywhere on the globe may thus yield an improved HF parameter prediction algorithm. to test the efficacy of the hypothesis, one has to ascertain the correlation between the TEC daily variability about the monthly mean and the f(sub 0)F(exp 2) variability. To determine such correlation a study was conducted using Faraday TEC data as well as GPS generated TEC data collected in Israel and comparing it to f(sub 0)F(exp 2) measurements near the appropriate subionospheric location in Cyprus. The analysis shows that for large percentages of the time very good correlation exists between TEC and f(sub 0)F(exp 2) short-term variations. The correlation coefficient varies between 0.7 or better during winter and summer months to about 0.5 - 0.6 during equinox months. A study of the diurnal dependence of the correlation indicates that a better correlation exists during daytime than nighttime. There was no indication that the coefficient is dependent on geomagnetic activity during the period of this study.
Author
Wave Propagation; High Frequencies; Communication; Reliability; Earth Ionosphere

19970000238 Rutherford Appleton Lab., Radio Communications Research Unit, Chilton, United Kingdom
A RAY-BASED PROPAGATION TOOL FOR DIGITAL SYSTEMS
Charriere, P., Rutherford Appleton Lab., UK; Craig, K. H., Rutherford Appleton Lab., UK; Apr. 1996; 12p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The paper describes the development of a practical, deterministic ray-based propagation tool for the prediction of the performance of wideband digital systems. Applications over a wide frequency range from VHF to millimetric waves are considered, with emphasis on propagation in the urban environment. The discussion covers the propagation mechanisms, database and computational issues, system applications and model validation.
Author
Very High Frequencies; Data Bases; Digital Systems; Analog Simulation

19970000239 Bell Telephone Labs., Inc., Holmdel, NJ United States
UHF AND MICROWAVE PROPAGATION PREDICTION IN AN URBAN ENVIRONMENT
Willis, T. M., Bell Telephone Labs., Inc., USA; Guarino, B. J., Bell Telephone Labs., Inc., USA; Moore, J. D., Bell Telephone Labs., Inc., USA; Luebbers, Raymond, Pennsylvania State Univ., USA; Schuster, Joseph, Pennsylvania State Univ., USA; Bertoni, Henry L., Polytechnic Univ., USA; Liang, George, Polytechnic Univ., USA; Wo, Nai, Polytechnic Univ., USA; Rappaport, Theodore S., Virginia Polytechnic

Inst. and State Univ., USA; Koushik, Prabhakar M., Virginia Polytechnic Inst. and State Univ., USA; Apr. 1996; 12p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper discusses ongoing work by AT&T Bell Laboratories, Pennsylvania State University, Polytechnic University and Virginia Polytechnic University in developing site specific urban propagation computer models. Both two and three dimensional ray tracing algorithms have been developed by the different organizations and applied in the Rosslyn VA area at 900 and 1900 MHz. After the models have predicted the propagation loss from specific transmitter sites to receiver locations, measurements have been taken to determine the actual values. This paper presents some comparisons of the different models and measurements. Where the computer models have worked well, they are typically within about 7 dB of measurements. In some areas of Rosslyn there are known problems with the building data base where predictions differ from measurements, however work is continuing to improve the models in other problem areas. This will be accomplished by comparing the different models to one another and the measurements and then refining the models.
Author
Microwaves; Wave Propagation; Ultrahigh Frequencies; Prediction Analysis Techniques; Computerized Simulation

19970000240 Advanced Research Projects Agency, Arlington, VA United States
MILITARY APPLICATIONS OF SITE-SPECIFIC RADIO PROPAGATION MODELING AND SIMULATION
Bauman, Ronald M., Advanced Research Projects Agency, USA; Apr. 1996; 14p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

New electromagnetic propagation code suitable for use in complex urban environments has recently been developed and demonstrated by a collaborative group of researchers. These methods use a combination of two- or three-dimensional ray tracing reflection, diffraction, diffuse scattering, and transmission rather than electromagnetic field theory to solve the path loss problem. Although still under development, initial versions of the code predict propagation in complex urban environments with useful accuracy. Looking beyond this research, this paper addresses potential military use of site-specific propagation models and simulations, focussing on its use in distributed interactive simulations
Derived from text
Military Technology; Propagation Modes; Simulation; Radio Transmission

19970000241 Computer Sciences Corp., Systems Engineering Div., Falls Church, VA United States
A MODEL FOR ESTIMATING ELECTROMAGNETIC WAVE ATTENUATION IN A FOREST (EWAF) ENVIRONMENT
Welch, Conrad, Computer Sciences Corp., USA; Lemak, Catherine, Computer Sciences Corp., USA; Corrington, Lee, Army Electronic Proving Ground, USA; Apr. 1996; 6p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

For decades, communicators have been concerned with Radio Frequency (RF) propagation path loss through foliage. This paper describes the development and implementation of the Electromagnetic Wave Attenuation in a Forest (EWAF) propagation path loss model, which uses conventional inputs to estimate plausible foliage losses. The EWAF is an elementary, heuristically based foliage propagation path loss model which represents a forest as a dissipative dielectric slab lying in a more lossy half-space representative of the ground. Modeling the foliage by a dielectric slab will provide an estimate of foliage path loss in excess of free space (EPL) expected in situations where meager information is available regarding the wood density and other electrical parameters of the forest. The EWAF model uses empirical foliage path loss information as a basis and is therefore closely coupled to actual path losses encountered in real-world situations. The EWAF model is not a rigorous attempt to solve the electromagnetic wave equations at the boundaries of the different representative dielectric slabs. Rather, EWAF is essentially a family of curve-fitting algorithms based on previously measured data for sparse and dense forests in the USA and Germany, as well as very dense forests in India, where the mean annual rainfall is about 3000 millimeters. The EWAF model includes several features: the effects of antennas within the forest, outside the forest, and above the forest; wave polarization; forest density; canopy, trunk, and undergrowth losses; antenna beamwidth; wet foliage; lush foliage; and other physical/forest conditions. It is presently resident on a Sun SPARC network and provides a good estimator for EPL due to foliage anywhere in the world.
Derived from text
Electromagnetic Wave Transmission; Radio Frequencies; Losses; Dissipation; Foliage

19970000242 Forschungsinstitut fuer Hochfrequenzphysik, Werthoven, Germany
ATMOSPHERIC PATH LOSS AND SCINTILLATIONS AFFECTING COMMUNICATIONS IN THE EHF FREQUENCY RANGE
Fuchs, H. H., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Makaruschka, R., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 8p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

With the introduction of millimeter wave bands for satellite communications attenuation effects in the troposphere become adversely important. to investigate these propagation phenomena especially due to clouds an experiment has been set up on a 9420 m slant line-of-sight path in the German Alps between Garmisch and the top of the Zugspitze. The measurements were made at the frequencies of 35 GHz and 94 GHz. Hourly observations of the German Weather Service at both locations gave estimates of the height, thickness and type of the clouds. The measured data were evaluated in a statistical manner. Comparing the results with calculations based on standard drop size distributions for various cloud types an increase in the attenuation levels was observed. This difference can be explained by the presence of super-large drops in clouds as recently measured and reported. Though their contribution to the total liquid water content is small, the effect on the attenuation is enhanced. A second propagation experiment was performed on a 1340 m long, terrestrial line-of-sight path to evaluate the scintillation effects at 94 GHz. It was found that the power spectrum of the measured log-amplitudes follows the -8/3 slope of the theoretical pattern based on Kolmogorov's refractive index spectrum. The refractive index structure constant C ((sub n)(exp 2)) calculated from variances of the measured log amplitude agree well with those deduced from meteorological measurements after applying a semiempirical relation for height scaling the various sensors. This result establishes the applicability of theoretical relations for scintillation effects at mm-waves due to Tatarski and Kolmogorov.
Author
Losses; Extremely High Frequencies; Scintillation; Telecommunication

19970000243 York Univ., Dept. of Electronics, United Kingdom
CHARACTERISATION OF THE TRANSFER FUNCTION OF THE CLEAR ATMOSPHERE AT MILLIMETRE WAVELENGTHS
Papatsoris, A. D., York Univ., UK; Apr. 1996; 6p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A model for the calculation of the absorption and dispersion spectra of the most important and millimetre-wave active atmospheric gases for arbitrary atmospheric geometries is presented. The model adopts a line-by-line summation technique to characterize the resultant resonant absorption and dispersion spectra of various trace constituents and major contributors H2O and O2. A spherically layered atmosphere is assumed with each layer taken to be in Local Thermodynamic Equilibrium (LTE) with exponential profiles of density and pressure between layer boundaries. The relative air mass integral and the lineshape functions are also appropriately evaluated according to atmospheric conditions. Various model atmospheres may be selected or specified by the user.
Derived from text
Millimeter Waves; Functions (Mathematics); Absorption Spectra; Atmospheric Models

19970000244 MATRA Marconi Space Systems, Stevenage, United Kingdom
MILSATCOM: WHERE ARE WE NOW?
Cairns, J. B., MATRA Marconi Space Systems, UK; Watson, J. R.,

MATRA Marconi Space Systems, UK; Apr. 1996; 6p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The military use of space for communications has seen dramatic changes since its first use in the 1960's. This paper presents some of the advances made, explores some of the current technical trends and proposes some key areas which need to be addressed in the future. The use of 3-axis stabilized rather than spin stabilized satellites has enabled a significant increase in the DC power which can be generated using large solar arrays and has provided the platform necessary to mount sophisticated electronics and large, complex antenna systems. The advantages of satellite communication over terrestrial systems in terms of coverage, availability and ruggedness are now widely accepted. The modern demand for highly flexible and rapid force deployment by NATO and Allied powers has further strengthened the case for satellite communications. Survivable communications is a vital component in the C(exp 3)I systems necessary for efficient military deployments during stress. The Gulf Conflict demonstrated for the first time the full potential of space systems in military operations. Satellite communications in particular played an essential role in support of all operations both land based and shipborne. Satellite communications continue to provide vital support to NATO activities in Bosnia. At a time when budget pressures are leading to critical reviews of expenditures amongst allied nations the need for the retention of a highly resilient space resource remains paramount. The end of the Cold War has not fundamentally reduced the potential threats to the Allied nations. Satellites remain a key resource to maintain both national security and for humanitarian and peace keeping roles worldwide.

Derived from text

Satellite Communication; International Relations; Military Operations

19970000245 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA United States

EARTH-SPACE LINKS AND FADE-DURATION STATISTICS

Davarian, Faramaz, Jet Propulsion Lab., California Inst. of Tech., USA; Apr. 1996; 6p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In recent years, fade-duration statistics have been the subject of several experimental investigations. A good knowledge of the fade-duration distribution is important for the assessment of a satellite communication system's channel dynamics: What is a typical link outage duration? How often do link outages exceeding a given duration occur? Unfortunately there is yet no model that can universally answer the above questions. The available field measurements mainly come from temperate climatic zones and only from a few sites. Furthermore, the available statistics are also limited in the choice of frequency and path elevation angle. Yet, much can be learned from the available information. For example, we now know that the fade-duration distribution is approximately lognormal. Under certain conditions, we can even determine the median and other percentiles of the distribution. This paper reviews the available data obtained by several experimenters in different parts of the world. Areas of emphasis are mobile and fixed satellite links. Fades in mobile links are due to roadside-tree shadowing, whereas fades in fixed links are due to rain attenuation.

Author

Data Links; Data Acquisition; Satellite Networks; Telecommunication; Signal Fading Rate

19970000246 Mons Univ., Service d'Electromagnetisme et de Telecommunications, Belgium

OPTOGEOMETRICAL CHARACTERISATION OF ERBIUM DOPED FIBRES

Ravet, F., Mons Univ., Belgium; Heens, B., Mons Univ., Belgium; Megret, P., Mons Univ., Belgium; Blondel, M., Mons Univ., Belgium; Jaunart, E., Belgacom, Belgium; Apr. 1996; 6p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The reliability of the new photonic network components is becoming one of the challenges of the present years. The Erbium Doped Fibre (EDF) can be considered as one of these devices contributing to the optical communication systems upgrading. These are the reasons why easy-to-reach EDF optogeometrical properties seem to be more and more important. Within this context, an experimental set-up has been developed permitting the measurements of these properties (mode field diameter, core diameter, refractive index profile, Numerical Aperture...). Our set-up is based on the Transmitted Near Field Technique (TNFT), combined with an infra red camera detecting the near field intensity magnified by an infra red aspherical lens. Such a method has been successfully demonstrated in the past for the optogeometrical characterization of single mode fibres. The combination of the TNFT with the infra red camera opens the possibility of yielding very quick measurements. The importance of the camera lies in the two dimensional intensity detection: such a device records and instantaneously displays the intensity distribution. The NFI pattern is thus easy to get. The mode field diameter has been determined from the Near Field Intensity (NFI) pattern and we then calculated the refractive index profile difference. Finally, we determined the fibre core radius and numerical aperture. We then compared them with the Equivalent Step Index parameters we have calculated. We carried out all these measurements at 1310 nm and 1550 nm. So we have direct informations on the optogeometrical parameters in the second and third windows.

Author

Fibers; Optical Communication; Telecommunication; Erbium

19970000247 Defence Research Agency, Radio Science and Propagation Group, Malvern, United Kingdom

MEASUREMENTS OF DOPPLER SPREAD ON HIGH LATITUDE HF PATHS

Angling, M. J., Defence Research Agency, UK; Cannon, P. S., Defence Research Agency, UK; Davis, N. C., Defence Research Agency, UK; Lundborg, B., Swedish Inst. of Space Physics, Sweden; Jodalen, V., Norwegian Defence Research Establishment, Norway; Moreland, K. W., Communications Research Centre, Canada; Apr. 1996; 10p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The increased sophistication of the modulation schemes employed by High Frequency (HF) data modems has necessitated a better understanding of the effects of the ionosphere on propagated signals. This paper describes an HF pulse compression radio sounder, that is being used to characterize high latitude HF paths. Results from operations of the sounder in Scandanavia are also presented.

Derived from text

Acoustic Measurement; Doppler Effect; High Frequencies

19970000248 Leicester Univ., United Kingdom

OBSERVATIONS OF DOPPLER SPREADING AND FSK SIGNALLING ERRORS ON HF SIGNALS PROPAGATING OVER HIGH LATITUDE PATHS

Dhanda, B. S., Leicester Univ., UK; Warrington, E. M., Leicester Univ., UK; Jones, T. B., Leicester Univ., UK; Apr. 1996; 14p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The auroral zone ionosphere forms a highly dynamic and disturbed medium which can severely degrade the performance of HF radio links when the signals propagate through these regions. In order to investigate this effect, a series of experiments have been undertaken over a variety of high latitude paths for which the Doppler spreading imposed on the signal by the ionospheric reflection processes and FSK data signalling error rates and distributions were measured. The Doppler spreads observed over two of these high latitude propagation paths are examined in this paper for two experimental campaigns, one conducted during the summer months and the other during winter months. One of these paths was contained entirely within the polar cap and another of the paths was sometimes entirely within the polar cap and at other times crossed the auroral oval. Times of increased Doppler spreading on the second path were found to be well correlated with periods for which one of the ionospheric reflection points was within, or close to, the boundaries of the statistical position of the auroral oval. The bit error rate of the FSK signals was not influenced by the high level of Doppler spreading observed on the path crossing the auroral oval. However, the distribution of bit errors was markedly affected by changes in the Doppler spreads. At times of high Doppler spreading, the length of the error bursts was significantly less than for the cases where the Doppler spreading was small.

Derived from text

Observation; Doppler Effect; Frequency Shift Keying; Errors; High Frequencies; Signal Transmission; Polar Regions

19970000249 Thomson-CSF, Gennevilliers, France
COMPARISON BETWEEN SERIES AND PARALLEL WAVE FORMS FOR HIGH FREQUENCY TRANSMISSION ***COMPARAISON ENTRE LES FORMES D'ONDE SERIE ET PARALLELE POUR LES TRANSMISSIONS HF***
Pirez, Didier, Thomson-CSF, France; Merel, Dominique, Thomson-CSF, France; Apr. 1996; 8p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Here we compare wave forms that are both capable of coherent demodulation by virtue of the presence of reference symbols. First, we attempt to compare the intrinsic performance parameters of wave forms in the case of CCIR type channel model (several trajectories for a few milliseconds affected by independent Rayleigh fadings). In this type of channel, the parallel wave form should behave as in the presence of a flat fading. The form of a series wave should benefit from the diversity effect related to independence of the fadings, and therefore should present greater error rate curves, the intrinsic performance parameters in presence of a single trajectory being identical.
Derived from text
Waveforms; Comparison; High Frequencies; Transmission Rate (Communications)

19970000250 Leeds Univ., Communications and Signal Processing Research Consortium, United Kingdom
CHANNEL EVALUATION FROM PREDICTED ZERO-CROSSING ANALYSIS
Piggin, P. W., Leeds Univ., UK; Gallagher, M., Leeds Univ., UK; Apr. 1996; 8p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper presents an investigation into Real-time Channel Evaluation (RTCE) from predicted zero-crossing analysis of: (1) A pilot-tone, and (2) Frequency Shift Keying (FSK) modem tones within a HF (High Frequency) radio system. This work extends the initial investigations from the early 1970s which used an analogue implementation analyzing phase perturbation by time-differential phase comparisons of a low-level pilot-tone inserted in-band. The results to be presented in this paper compare theoretical analysis and measured results in Gaussian and flat fading conditions, and hence identify the close relationship between phase threshold, zero-crossing error rate and SNR (Signal-to-Noise Ratio). It will conclude with recommendations for extending the applicability of the technique to FSK (Frequency Shift Keying) systems and outline methods for incorporation into frequency management systems for various different radio systems operating in the HF, VHF and UHF bands.
Derived from text
Real Time Operation; Channels (Data Transmission); Evaluation; High Frequencies

19970000251 Daimler-Benz Aerospace A.G., Research and Technology, Ulm, Germany
NEW TECHNOLOGIES TO IMPROVE HF MODEMS PERFORMANCE FOR STANDARDIZED WAVEFORMS
Brakemeier, Achim, Daimler-Benz Aerospace A.G., Germany; Kotlowski, Andre, Daimler-Benz Aerospace A.G., Germany; Apr. 1996; 8p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

For military short wave communication systems two waveforms have been standardized-STANAG 4285 and MIL-STD-188-110A. For these waveforms modems are available on the market. In this paper design rules that have led to these waveforms are recalled briefly and compared with modern signal design techniques. Knowing the shortcomings of standardized waveforms, the incorporated redundancy has been intensively used for advanced modem design. These new technologies have proved great performance enhancements in Daimler-Benz Aerospace new HF modem Echotel ETM1810/M for STANAG 4285 and MIL-STD-188-110A waveforms. Improvements have been achieved mainly in tolerance to Doppler and Delay Spread. Results are presented in this paper.
Author
High Frequencies; Modems; Improvement; Waveforms; Standardization

19970000252 Centre National d'Etudes des Telecommunications, Lannion, France
DECISION MAKING HELP IN THE SEARCH FOR CLEAR CHANNELS IN THE DECAMETRIC BAND ***AIDE A LA DECISION POUR LA RECHERCHE DE CANAUX CLAIRS DANS LA BANDE DECAMETRIQUE***
Wolf, J., Ecole Nationale Superieure de Sciences Appliquees et Technologie, France; LeRoux, Y. M., Centre National d'Etudes des Telecommunications, France; Apr. 1996; 8p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The National Telecommunication Research Center (CNET) has a connection analyzer available that allows one to measure, on the one hand, the main propagation parameters of the ionosphere channel and, on the other hand, the spectral occupancy rate of this channel. In the article, a method is proposed that allows one to discriminate and to simply quantify this spectral occupancy rate in order to serve as the basis for subsequent studies of the search for clear channels in an operational context.
Derived from text
Telecommunication; Acoustic Measurement

19970000253 Paris-Sud Univ., LETTI, Orsay, France
ELECTROMAGNETIC COMPATIBILITY IN THE DECAMETRIC BAND: MODELING, PREDICTION, PASSIVE EVALUATION OF THE IONOSPHERE ***COMPATIBILITE ELECTROMAGNETIQUE DANS LA BANDE DECAMETRIQUE: MODELISATION, PREVISION, EVALUATION PASSIVE DE L'IONOSPHERE***
Caratori, J., Paris-Sud Univ., France; Goutelard, C., Paris-Sud Univ., France; Apr. 1996; 10p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The decametric band spectrum reveals a very large number of interferences whose distribution will depend on users and the condition of the ionosphere. A modeling of the interferences can be carried out by observing the received levels over the entire range. It has been possible to carry out such a classification with respect to the field level captured at one point of the ground surface.
Derived from text
Decametric Waves; Earth Ionosphere

19970000254 Rennes Univ., Lab. Radiocommunications, France
EVALUATION OF COHERENCE BANDWIDTH FOR LONG DISTANCE VHF/UHF TRANSMISSIONS ***EVALUATION DE LA BANDE DE COHERENCE DU CANAL DE TRANSMISSIONS VHF/UHF LONGUES DISTANCES***
Aignel, G., Rennes Univ., France; Ravard, O., Rennes Univ., France; Sorais, D., Thomson-CSF, France; Bertel, L., Rennes Univ., France; Apr. 1996; 8p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper deals with the problem of coherence bandwidth of troposcatter radio links in the VHF frequency range. Partial reflections (specular and diffuse) on tropospheric sheets (feuillets) is the propagation mechanism considered. A propagation model (ASTRAL), which considers the appearance of such rough surface in the common volume, is then used. For a given VHF link, a numerical integration allows the determination of the received power. In this paper, we show that modelling the troposcatter propagation in such a way allows the evaluation of the coherence bandwidth of the channel by calculating the power delay profile. Some numerical examples are given and discussed.
Author
Coherent Scattering; Very High Frequencies; Tropospheric Scattering; Radio Frequency Interference

19970000255 Boston Univ., Centre for Space Physics, Boston, MA United States
COMMUNICATIONS AND THE GLOBAL POSITIONING SYSTEM
Aarons, Jules, Boston Univ., USA; Mendillo, Michael, Boston Univ., USA; Yantosca, Robert, Boston Univ., USA; Apr. 1996; 14p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Position data obtained by use of the Global Positioning System (GPS) form basic components in a myriad of military and commercial systems. These range from navigating harbors and oceans to determining aircraft, rocket, and satellite positions. The users of GPS envisage automatic and routine communication of results of position

data for control and location of resources. Propagation studies to support these needs require the evaluation of problems of finding the position of ground, naval and airborne units and then communicating the data. The area addressed by this paper outline the problems of global fading of signals for both the GPS system and the satellite communication systems at 250 MHz which are used to communicate and integrate results. For GPS frequencies (1.2 GHz and 1.6 GHz) difficulties will be encountered in the auroral region during magnetic storms during all phases of the sunspot cycle. The equatorial and polar regions will become important by the end of the millenium when the sun will exhibit maximum activity. The data base for evaluating the effects of the ionosphere on gigahertz scintillation is small but will be outlined in this paper. The effects of F layer ionospheric irregularities on communication links at 250 MHz are considerable even during the current solar minimum. The data base for ionospheric effects on satellite communication systems at 250 MHz is large and will be only briefly outlined; much of the material is in various publications. It should be noted that transmissions for the IRIDIUM series of satellites are in the same frequency band as the GPS transmissions and will be affected by F layer scattering.
Derived from text
Communication Networks; Global Positioning System; Data Acquisition; Telecommunication

19970000256 Office National d'Etudes et de Recherches Aerospatiales, Toulouse, France
MODELING AND MEASUREMENT OF RADIOWAVE PROPAGATION ON EARTH-SATELLITE LINKS IN THE MILLIMETRE BAND ***MODELISATION ET MESURE DE LA PROPAGATION RADIOELECTRIQUE SUR LES LIAISONS TERRE-SATELLITE DANS LA BANDE MILLIMETRIQUE***
Castanet, L., Office National d'Etudes et de Recherches Aerospatiales, France; Douchin, N., Office National d'Etudes et de Recherches Aerospatiales, France; Lemorton, J., Office National d'Etudes et de Recherches Aerospatiales, France; ColasdesFrancs, R., Centre d'Electronique de l'Armement, France; LeBoulch, D., Centre d'Electronique de l'Armement, France; Grely, S., STSIE, France; Apr. 1996; 10p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

To prepare future satellite telecommunication systems, French military administration (DGA: Delegation Generale de l'Armement) needs to validate propagation prediction models in the EHF band. In order to assess the validity area of these models and to improve the knowledge of Earth-Space propagation at these frequencies, DGA is planning EHF experimentations in relation with the anticipated CNES (Centre National d'Etudes Spatiales) experimental satellite STENTOR.
Derived from text
Radio Waves; Wave Propagation; Millimeter Waves

19970000257 Thomson-CSF, Gennevilliers, France
ATTENUATION OF EFFECTS AND MULTIPLE TRAJECTORIES AND INTERFERENCE IN MILITARY RADIO COMMUNICATION BY SIGNAL PROCESSING ***L'ATTENUATION DES EFFETS DE TRAJETS MULTIPLES ET DE L'INTERFERENCE DANS LES COMMUCATIONS RADIO MILITAIRES PAR LE TRAITEMENT DU SIGNAL***
Multedo, G., Thomson-CSF, France; Goudezeune, G., Thomson-CSF, France; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 12p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The evolution of digital technology and general implementation of digital RF communications has opened up a vast field of application for signal processing in order to implement the very large number of its theoretical and hardware tools for service of information transmission devices. The amounts of information that can be transmitted are growing. They pertain to voice, command control, but also data, fax, and image transmission capabilities.
Derived from text
Radio Communication; Signal Processing; Command and Control

19970000258 Paris-Sud Univ., LETTI, Orsay, France
GQ SEQUENCES, Q-AIRY ORTHOGONAL SEQUENCES WITH PERFECT CORRELATION ***LES SEQUENCES, GQ SEQUENCES Q-AIRE ORTHOGONALES A CORRELATION PARFAITE***
Goutelard, C., Paris-Sud Univ., France; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 14p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The search for sequences that offer good periodic correlation functions is a subject on which a number of studies have been carried out. It has been demonstrated that with the exception of a trivial case, there are no binary sequences with perfect correlation. Some binary sequences with almost perfect correlation, the WG (Wolfmann-Goutelard) sequences, were proposed in 1992. These sequences are such that outside the central peak of correlation and a point located in the middle of the period of the correlation function, this function is always null. The perfect correlation sequences can therefore exist in the Q-airy sequences only. The GQ (Goutelard Q-airy) sequences are sequences that offer perfect correlation functions and which can be broken down into orthogonal subsequences with almost perfect correlation.
Derived from text
Sequencing; Correlation

19970000259 Alcatel Espace, Nanterre, France
DISCRETE HILBERT TRANSFORM
Marguinaud, A., Alcatel Espace, France; Gienger, S., Alcatel Espace, France; Apr. 1996; 12p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Analytic signal processing has gained wide acceptance in the electronics community and it is important to define the transform family which allows regular analytic samples of a signal to be calculated from its real sampling. This paper is composed of three main parts. The first part shows that band limited continuous signals are well approximated by trigonometric polynomials whose frequencies lie within a frequency band of the same width, and that we may thus represent these signals by analytic samples. The second part is devoted to the derivation of an explicit formula for the weighting coefficients used to calculate the two cartesian coordinates of the complex samples. The third part reviews some properties of this transform from the signal processing standpoint.
Derived from text
Hilbert Transformation; Signal Processing

19970000260 Forschungsinstitut fuer Hochfrequenzphysik, Werthoven, Germany
EFFECTS OF BANDWIDTH REDUCTION OF TRANSMITTED MOTION PICTURE SEQUENCES ON HUMAN RECOGNITION PERFORMANCE
Gaertner, Klaus-Peter, Forschungsinstitut fuer Hochfrequenzphysik, Germany; Schneider, Frank E., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Apr. 1996; 6p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Research Institute for Human Engineering (FAT) has been working in the field of land telerobot systems for the last six years. The main goal of current research work is the optimization of remote control and supervision of semiautomatic vehicles from a single control station for various missions. The research work done on a particular aspect of robot deployment in a driving task will be described in this paper. Robots are likely to be positioned at particular locations or to be moving in a terrain overlooking areas of military interest, such as likely enemy positions, contested areas, or supply lines. During the moving operation the robot is autonomous and ready to detect obstacles in a selected part of the landscape in front of it. After the robot is programmed with its mission there is no need for further radio communication until an obstacle is sensed which it cannot interpret because the automatic recognition system cannot recognize all threatening object situations for the driving task. 'Upon request', the vehicle requires help and support from humans. In this case the human acts

as a remote controller and supervisor. In a remote control station he receives still pictures or picture sequences obtained from the vehicle over a communication channel.
Derived from text
Bandwidth; Motion Pictures; Sequencing; Human Performance; Images; Transmission Rate (Communications)

19970000261 Telekom Forschungszentrum, Forschungs- und Technologiezentrum, Darmstadt, Germany
ANALYSIS OF PROPAGATION EFFECTS AND NON-LINEAR DISTORTIONS ON DIGITAL MODULATION SCHEMES
Metzger, Kurt, Telekom Forschungszentrum, Germany; Valentin, Rolf, Telekom Forschungszentrum, Germany; Apr. 1996; 8p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The paper deals with the analysis of digital transmission systems which are corrupted by thermal noise, linear channel dispersion and nonlinear distortions which are caused by the transmit amplifier. The central part of this analysis is a recursion model for the calculation of the probability density function (pdf) of Intersymbol Interference (ISI). The nonlinearity introduces statistical interdependencies between the interfering symbols and these dependencies are implicitly taken into account in a trellis-structured recursion rule. The procedure was applied to 4-level modulation schemes such as 4-QAM, offset 4-QAM and linearized GMSK. The results were verified by time consuming Monte-Carlo simulation and show, e.g., that the nonlinear characteristic of a high power amplifier (HPA) reduces in some cases the error probability caused by the linear dispersion. Surprisingly, the ISI due to the nonlinear amplifier is increased in the case of offset modulation.
Author
Radio Transmission; Probability Density Functions; Intersymbolic Interference; Quadrature Amplitude Modulation; Monte Carlo Method; Digital Systems; Signal Distortion

19970000262 Alcatel Espace, Nanterre, France
INTEGRATED DATA AND CHANNEL ESTIMATION FOR SELECTIVE FADING CHANNELS
DAmbrosio, Luca, Aquila Univ., Italy; Marchesani, Rossano, Alcatel Espace, France; Ruggieri, Marina, Aquila Univ., Italy; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 8p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Per-Survivor Processing is a general approach including in the survivors of the Viterbi Algorithm trellis the relative estimation of unknown parameters; this expensive method better approximates the optimum decoder in some conditions. The method is applied to the case of a typical HF channel and performance is evaluated. Some reduced complexity implementations are also evaluated and relative performances reported.
Author
Viterbi Decoders; Data Transmission; Selective Fading; Multipath Transmission; Channels (Data Transmission)

19970000263 Shape Technical Center, The Hague, Netherlands
LINK LEVEL PROTOCOLS FOR RADIO CHANNELS
Yavuz, Davras, Shape Technical Center, Netherlands; Apr. 1996; 8p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Describing and/or modelling the characteristics of transmission channels is the most important aspect of performance estimation for most communication systems. Many analytic techniques for determining performance under well defined conditions such as additive Gaussian noise, Poisson impulsive noise, exist. However, some channels are too complex in terms of noise effects, interference and time variability to model with fidelity. The most outstanding example of this is the HF sky wave channel for which 'some good channel simulator performance' is required prior to fielding of a system. However, in general this is only a necessary but not sufficient condition for acceptable on-air performance. Link level or layer two protocols provide an excellent means to reduce the effects of such uncertainties. The basic approach is to use packetization (packet radio) to allow an automatic request for repeat (ARQ) process to continuously trade-off throughput with channel conditions. Many other facilities such as link establishment/maintenance and adaptive modem speed control can also be incorporated. With such an approach the source information (data, message, fax, image and packet digital voice) will always be communicated to the destination with no errors but the transmission (or delivery) time will vary with channel conditions; the worse the channel the longer it will take to transmit the information. Packet radio techniques were originally developed by DARPA for networking and survivable multihoming applications over terrestrial/fixed links. However, the link level applications over complex channels are now increasing significantly. This paper/presentation will present examples of link level protocol work that has been performed at SHAPE Technical Center. Specifically, link level ARQ protocols developed for HF sky wave and meteor burst communications will be covered. More recent work on a packet radio protocol for data communications over analog frequency hopping radio systems will also be described.
Author
Radio Communication; Sky Waves; Packet Transmission; Data Links; Automatic Repeat Request; Channels (Data Transmission)

19970000264 Alcatel Espace, Nanterre, France
DEFINITION OF A COMMUNICATION SYSTEM USING THE TROPOSPHERIC CHANNEL
Vivier, G., Alcatel Espace, France; Brelivet, P., Alcatel Espace, France; Richard, J., Alcatel Espace, France; Sehier, P., Alcatel Espace, France; Apr. 1996; 8p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Many transmission channels, like the radio channel or the tropospheric channel, are frequency selective and time variable. Receivers designed for this type of transmission have to fight against intersymbol interference generated by the multiple paths and at the same time adapt to the time variations of the channel. Only with progress in digital technology, leading to the application of new concepts of advanced equalization and error correcting codes, will good quality, high bit rate transmission become achievable on this type of channel. This article covers high bit rate communications (of the order of 8 Mbit/s). The first part discusses the special features of the tropospheric channel and system aspects that must be considered when attempting a complete definition of a communication system on this channel. The second part describes two waveforms, associated with their respective receivers, designed to meet the requirements identified in the first part. The first, designed for a single-carrier modulation system, is based on an architecture combining equalization, decoding and deinterleaving. This method, introduced by R. Mehlan and H. Meyr, is called Combined Equalization and Decoding (CED) in the remainder of this article. The second is a single-carrier alternative known as Coded Orthogonal Frequency Division Multiplexing (COFDM), adopted for digital audio broadcasting (DAB), and envisaged for digital terrestrial TV broadcasting. In the second part, we attempt to compare these two methods in terms of Bit Error Rate (BER), obtained by simulations in conditions approximating a real link, and in terms of difficulty of implementation.
Author
Radio Transmission; Frequency Division Multiplexing; Bit Error Rate; Troposphere; Channels (Data Transmission); Waveforms; Equalizers (Circuits)

19970000265 Katholieke Univ. te Leuven, Div. ESAT-TELEMIC, Belgium
COMPARISON OF RLS ADAPTIVE ARRAY ALGORITHMS IN A STRONG MULTIPATH PROPAGATION ENVIRONMENT
Peeters, D., Katholieke Univ. te Leuven, Belgium; VanLil, E., Katholieke Univ. te Leuven, Belgium; Apr. 1996; 10p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Most of the algorithms for spatial multiplexing are tested under simple multipath conditions. In this paper a more complete and realistic model for the communication channel is described, taking into account local dispersion, Doppler-shift, multipath propagation and thermal noise. Based on this model, a program has been written to actually compute the effect of the complex environment on the signals. The numerical data for the multipath effect were taken from the GSM Recommendation 05.05 'Radio Transmission and Reception'. With the results of this propagation simulation program, algorithms of the RLS type are compared. It is found that the difference in performance between the S-RLS algorithm and the QR-RLS algorithm is negligible. Because of the limited length of the training-sequence, the number of coefficients to be determined must be kept low. Additional time-equal-

ization does not improve the reception substantially. Also, due to the Rayleigh fading, the amelioration of the reception at decreasing noise levels stagnates.
Author
Multipath Transmission; Algorithms; Channels (Data Transmission); Bit Error Rate; Signal to Noise Ratios; Thermal Noise

19970000266 Katholieke Univ. te Leuven, Div. ESAT-TELEMIC, Belgium
TESTING HF-MODEMS: DSP'S OPEN NEW POSSIBILITIES AND MAKE NEW DEMANDS ON REAL-TIME HF-SIMULATORS
VanderPerre, Liesbet, Katholieke Univ. te Leuven, Belgium; VandeCapelle, A., Katholieke Univ. te Leuven, Belgium; Apr. 1996; 10p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A test set-up for HF-modems with a hardware implemented, mainly analogue simulator based on the Watterson model, has been built at the division ESAT-TELEMIC of the K.U.Leuven. It has shown to be a very useful tool to test narrowband HF-modems under stable channel conditions. In order to improve the transmission quality, more advanced HF-modems are being developed nowadays. The use of DSP's (Digital Signal Processing) has made it possible to provide large interleaving blocs, intelligent error correcting coding schemes, channel estimators, adaptive equalizers, etc... The qualities of such modems, that try to adapt to the present channel conditions, can only properly be tested on, provided they are subjected to varying channel conditions. The technological evolution that gave rise to these intelligent modems, has created the need for a simulator that can imitate a varying ionosphere. This is what is aimed using a digital signal processor for the realization of an HF-channel simulator. Besides the programming capabilities that are automatically present when using DSP's for channel simulation, other advantages come when working digitally. Making adjustments to a design becomes a very simple operation, and some simulation functions are easier to implement when working with digital technology. The design of this digital simulator is done using a digital signal processing design tool called Signal Processing Worksystem (SPW). The use of spread spectrum modulation techniques on the HF-channel, creates a new challenge for the developers of HF channel simulators. In the first place, because there is no wideband model for the HF channel available. Besides that, the realization of a real-time simulator that can handle signals with bandwidths up to 1 or 2 MHz, will be a complex task, both from a hardware and a software point of view.
Author
Modems; Real Time Operation; Channels (Data Transmission); Simulators; Data Transmission; Signal Processing; Digital Simulation; Spread Spectrum Transmission

19970000267 Kaiserslautern Univ., Research Group for RF Communications, Germany
A FLEXIBLY CONFIGURABLE STATISTICAL CHANNEL MODEL FOR MOBILE RADIO SYSTEMS WITH DIRECTIONAL DIVERSITY
Blanz, J. J., Kaiserslautern Univ., Germany; Jung, P., Kaiserslautern Univ., Germany; Baier, P. W., Kaiserslautern Univ., Germany; Apr. 1996; 12p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A prerequisite for the performance analysis and optimization of future mobile radio systems by simulation is a realistic model of the mobile radio channel. Time variance and frequency selective fading as well as spatial radio spreading have to be considered in such a model to enable the validation of system concepts using directional diversity. In this paper, a flexibly configurable statistical channel model for mobile radio systems using directional diversity is presented. This channel model is based on the superposition of echoes which originate from different scattering objects. The parameters of this model can be easily adjusted to various propagation areas as e.g., rural, urban, microcellular, and picocellular environments. Therefore, the model which is the basis for a FORTRAN77 program is well suited to perform simulations, evaluations and comparisons of mobile radio systems. Simulation examples are given for typical mobile radio scenarios. The resulting time varying channel impulse responses for both omnidirectional as well as ideal non-overlapping sector antennas are compared. The applicability of the presented channel model to simulations of mobile radio systems is demonstrated for a new mobile radio system concept with joint detection (JD) and directive base station antennas.
Author
Mobile Communication Systems; Radio Communication; Channels (Data Transmission); Bit Error Rate; Multipath Transmission; Monte Carlo Method

19970000268 Mons Univ., Service d'Electromagnetisme et de Telecommunications, Belgium
ERROR PROBABILITY COMPUTATION IN OPTICAL FIBER LINKS
VanDroogenbroek, M., Mons Univ., Belgium; Megret, P., Mons Univ., Belgium; Blondel, M., Mons Univ., Belgium; Apr. 1996; 4p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Several techniques to compute error probability in optical communication systems exist. Three methods of calculation are analyzed: Gaussian approximation, Gram-Charlier series and Gauss quadrature rule. Some results and comparisons for binary systems are presented.
Author
Computation; Error Analysis; Optical Fibers

19970000269 Mons Univ., Service d'Electromagnetisme et de Telecommunications, Belgium
GAIN-SWITCHED DFB LASERS AS SOLITON SOURCES FOR HIGH BIT RATE, LONG DISTANCE TRANSMISSIONS
Meuleman, L., Mons Univ., Belgium; Wang, X., Mons Univ., Belgium; Blondel, M., Mons Univ., Belgium; Apr. 1996; 6p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Numerical simulations of soliton transmission are presented. The optical pulses are delivered by a gain-coupled Distributed FeedBack (DFB) laser using a gain-switching technique. The important source features are reviewed, and a study of the timing jitter is described.
Derived from text
Distributed Feedback Lasers; Numerical Control

19970000270 Pennsylvania State Univ., Dept. of Electrical Engineering, University Park, PA United States
SITE-SPECIFIC RADIO PROPAGATION PREDICTION METHODS FOR URBAN ENVIRONMENTS
Luebbers, R., Pennsylvania State Univ., USA; Schuster, J., Pennsylvania State Univ., USA; Apr. 1996; 14p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

With high frequency portable communication systems becoming more common, the need for fast and accurate predictions of high frequency radio propagation in urban environments has rapidly increased. Until recently such predictions were usually based on empirical methods, especially if relatively large numbers of predictions were required. But advances in both computational methods and computer speeds now allow for fast, site-specific predictions of radio propagation even in complex urban areas. In this paper we are primarily concerned with narrow band signal attenuation, but the ray methods to be discussed are also applicable to determination of signal delay and delay spread. Various approaches being used for such predictions are discussed in this paper. The most popular current approaches involve some combination of shooting multiple rays and evaluating their amplitudes using diffraction theory. For this reason we will concentrate our paper on this approach. Basic considerations in the application of ray methods will be discussed, and some typical results are presented.
Derived from text
Prediction Analysis Techniques; Radio Transmission; Urban Development

19970000271 Communications Research Centre, Ottawa, Ontario Canada
AN IMPULSE RESPONSE MEASUREMENT SYSTEM AND SOME EXPERIMENTAL RESULTS FROM A FORWARD SCATTER METEOR BURST LINK
Ellis, K. J., Communications Research Centre, Canada; Webster, A. R., University of Western Ontario, Canada; Jones, J., University of Western Ontario, Canada; Chow, S., Communications Research

Centre, Canada; Apr. 1996; 12p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Meteor burst is a unique mode of communication which relies on the trails of ionization that are created when meteoric particles enter and burn up in the Earth's atmosphere. Due to the serendipitous nature of these events, these meteor burst channels are inherently intermittent but do possess characteristics which are attractive in military applications. Among these features are the potential for long-range communication (up to distances of 2000 km), low probability of jamming or intercept, and invulnerability to attack by either nuclear or conventional means.

Derived from text

Meteoroid Showers; Bursts; Probability Theory; Earth Atmosphere

19970000272 Rennes Univ., Lab. Radiocommunications, France

EXPERIMENTAL DESCRIPTION AND MODELIZATIONS OF METEORIC CHANNELS *DESCRIPTION EXPERIMENTALE ET MODELISATIONS DU CANAL METEORIQUE*

Ravard, O., Rennes Univ., France; Sorais, D., Thomson-CSF, France; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 10p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The meteoric channel can be described, over a given period of time, by the duty cycle and the mean waiting time. The objective of this paper is to give an analysis of the channels statistical parameters and to describe different kinds of channel modelling. The statistical analysis is based on experimental data. We show the effects of fading, observed on the received signal, on the channel parameters. We present different kinds of meteoric channel modelling which take account for underdense sporadic meteor trails. These modelling allow the consideration of the most important problems; the astronomical problem to evaluate the meteor distribution on the sky; the ionization problem to determine the electronic density created by the meteor; and the propagation problems. The performances of these modelling are evaluated.

Author

Ionization; Statistical Analysis; Density (Number/Volume); Meteor Trails

19970000273 Defence Research Agency, Radio Science and Propagation Group, Malvern, United Kingdom

BEAM FORMING TECHNIQUES IN METEOR SCATTER COMMUNICATIONS SYSTEMS

Akram, Ammad, Defence Research Agency, UK; Cannon, Paul S., Defence Research Agency, UK; Apr. 1996; 8p; In English, USA; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Experimental and modelling results from a program to improve the data throughput of meteor scatter communications systems are presented. The method of passive beam formation using a 4-element Butler matrix to improve the signal availability of meteor scatter communication systems is investigated. Butler matrix signal availability is compared with the performance of a single Yagi reference system using approximately 6.5 hours of data from a 720 km North-South temperate latitude link. The signal availability gain of the Butler matrix is found to range between 1.6-1.8 over the SNR threshold range 20-30 dB. At low SNR, the Butler matrix also compares favorably with a system employing adaptive beam formation driven by direction finding. The overhead time needed to continually direction find with the gain of a single antenna mitigates against the adaptive scheme at low SNR. For high SNR signals, however, the adaptive system outperforms the Butler matrix. A detailed computer model designed to predict the duty cycle of a general forward meteor scatter communications link has also been developed. The model incorporates effects such as major shower streams, a non-uniform radiant distribution and antenna polarization coupling, including Faraday rotation. A particularly useful aspect of the model is its capacity to predict the passage of hotspot regions across the sky. Experimental results are presented to validate the accuracy of these predictions. A computer controlled single high gain beam meteor scatter system is eventually envisaged.

Derived from text

Beamforming; Computerized Simulation; Numerical Control; Data Acquisition

19970000274 Katholieke Univ. te Leuven, Div. ESAT-TELEMIC, Belgium

COVERAGE AREA COMPUTATIONS: AN APPROACH WITH DIFFUSE REFLECTIONS

VanHoof, E., Katholieke Univ. te Leuven, Belgium; VanLil, E., Katholieke Univ. te Leuven, Belgium; RodriguezBlanco, F. J., Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Spain; Fontan, F. Perez, Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Spain; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 8p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

More and more computations of coverage areas of a transmitter are now deterministic as opposed to the empirical or semi-empirical methods that don't give the precision nowadays needed. The deterministic methods mostly use direct, specular reflected and diffracted rays. It has been shown recently, that specially for indoor propagation, the diffuse reflection cannot be neglected. Diffuse reflection is caused by the roughness of the terrain and can occur outside the incidence plane. In a digital terrain model, triangles can be used to accurately describe the environment. Therefore the classical formulas for diffuse reflection have to be adapted to make the use of triangles possible. Some mathematical problems that arise, caused by the division of the rectangle in two triangles, with two different center points, are discussed in this paper. As diffuse reflection is caused by the roughness of the terrain, this is an important parameter. This roughness is, just as the specular reflection coefficient, determined by the sort of terrain that reflects. Research has still to be conducted on the determination of this parameter, as well as on the optimal distribution. Finally this model is used in a program for computing the coverage area optical. It is especially useful in cases where the digital terrain model has a resolution of a few Lambda's and when computer time is not unlimited.

Derived from text

Computation; Transmitters; Diffuse Radiation; Reflected Waves; Reflection

19970000275 Bilkent Univ., Dept. of Electrical and Electronics Engineering, Ankara, Turkey

COMPUTER AIDED FREQUENCY PLANNING FOR THE RADIO AND TV BROADCASTS

Altintas, A., Bilkent Univ., Turkey; Ocah, O., Bilkent Univ., Turkey; Topcu, S., Bilkent Univ., Turkey; Tanyer, S. G., Bilkent Univ., Turkey; Koeymen, H., Bilkent Univ., Turkey; Apr. 1996; 6p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The frequency planning of the VHF and UHF broadcasts in Turkey is described. This planning is done with the aid of computer databases and digital terrain map. The frequency offset is applied whenever applicable to increase the channel capacity. The offset assignment is done through Simulated Annealing algorithm. The international rules and regulations concerning Turkey are also considered.

Derived from text

Computer Techniques; Channel Capacity; Very High Frequencies; Ultrahigh Frequencies; Computer Aided Design

19970000276 National Technical Univ., Dept. of Electrical and Computer Engineering, Athens, Greece

INTRODUCTION TO RURAL AREAS TELECOMMUNICATIONS AND DEVELOPMENT OF A PILOT TERMINAL UNIT

Makri, Rodoula, National Technical Univ., Greece; Gargalakos, Michalis, National Technical Univ., Greece; Uzunoglu, Nikolaos K., National Technical Univ., Greece; Apr. 1996; 10p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Rural areas present special characteristics which must be taken under consideration when designing their telecommunication networks. These characteristics and their effects on systems design are examined in detail. The design of a pilot terminal unit in a block diagram form is presented with a brief explanation of its specifications and subunits. Various applications of this system concerning rural areas are viewed. Modern applications such as telemedicine and tele-

teaching can be realized with the use of this system. Military use is also a promising perspective of the system. Alternative solutions that could increase systems capacity and range are also examined.
Derived from text
Rural Areas; Telecommunication; Utilization

19970000277 Advanced Research Projects Agency, Arlington, VA United States
COMMUNICATIONS AND SITUATION AWARENESS ON HOSTILE BORDERS
Kocher, R. W., Advanced Research Projects Agency, USA; Allen, J. G., Science Applications International Corp., USA; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 12p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In military operations, it is essential that commanders maintain an awareness of the location of subordinate units. The U.S. and other nations have deployed troops under United Nations' (UN) auspices to observe activity along potentially hostile borders. In these operations, there is always a danger that troops may inadvertently stray into a restricted area or cross a border. A system is needed to provide situation awareness by monitoring the position of soldiers (or the vehicles they are mounted in) and to warn when a soldier is entering a restricted area. Such warning should be provided to the soldier himself and also to higher echelons. If a higher echelon is aware of an emergency situation it may attempt to warn the soldier by independent means and also initiate the preparation of a reaction team.
Derived from text
Communication Networks; Borders; Deployment

19970000278 Army Communications-Electronics Command, Space and Terrestrial Communications Directorate, Fort Monmouth, NJ United States
COMMUNICATIONS REALISM WITH INTEGRATED TERRAIN-ENVIRONMENT-MULTIPATH MODEL
Sheth, Chandrahant, Army Communications-Electronics Command, USA; Barone, Salvatore, Army Communications-Electronics Command, USA; Lambert, Mark R., Maden Tech Consulting, Inc., USA; Kennedy, Lonnie R., Telos Corp., USA; Apr. 1996; 6p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Modeling and simulation (M&S) that assists the system developer or warfighter in defining, prototyping, testing and training should be executed with a high level of fidelity-this includes communications simulations. Current virtual, constructive, and systems performance simulations do not provide the dynamic irregularities at the lower link/physical layers that stress On-The-Move (OTM) communications, either assuming perfect communications or including statistical averages of error effects. The U.S. Army communications-Electronics Command Research, Development and Engineering Center (CECOM RDEC) has been developing models employing 'communications realism.' Communications realism is a simulation feature through which a synthetic environment reflects the same communications problems that exist in a real environment. The purpose is to provide realistic tools for developing OTM communications systems that ensure reliable connectivity on the digitized battlefield. The Combined Arms Command and Control (CAC2) Advanced Technology demonstration (ATD) is a key program for supplying digital capabilities for the USA Army's concept of the digitized battlefield. The CAC2 system performance model (SPM) was developed under the CAC2 ATD as an economical means of evaluating proposed system designs and modifications prior to costly field demonstrations and tests.
Author
Communication Equipment; Multipath Transmission; Simulation; Command and Control; Prototypes

19970000279 France Telecom International, Lannion, France
MULTI-PORT DIGITAL TRANSMISSION SYSTEM USING THE IONOSPHERIC PATHWAY *SYSTEME DE TRANSMISSION NUMERIQUE MULTI-PORTEUSES PAR VOIE IONOSPHERIQUE*
Rigaudeau, S., France Telecom International, France; LeRoux, Y. M., France Telecom International, France; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 10p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Propagation in the ionospheric channel is of the multiple-trajectory type and is progressive over time. The result is a degradation of transmissions via this medium, which is emphasized by different noises and jamming signals present in the decametric range. Time shifting of these trajectories reduces the speed of usable modulation. In order to reach rates of 2400 bits per second while preserving a reliable modulation speed, one distributes the information over a great number of subchannels. This technique of orthogonal frequency multiplexing justifies overlapping of the spectrums of a large number of subchannels. By thereby combining error correction convolution coding and coherent demodulation based on the criterion of a posteriori maximum likelihood, we obtained the transmission system described in this article.
Derived from text
Digital Systems; Ionospheric Propagation; Transmission Rate (Communications)

19970000280 Rennes Univ., Lab. Radiocommunications, France
THE INFLUENCE OF ANTENNAS AND PROPAGATION ON THE BEHAVIOR OF HF DIGITAL COMMUNICATIONS LINKS *INFLUENCE DES ANTENNES ET DE LA PROPAGATION SUR LE COMPORTEMENT D'UN SYSTEME DE TRANSMISSIONS NUMERIQUES EN HF*
Bertel, L., Rennes Univ., France; Lebaillif, O., Rennes Univ., France; LeRoux, Y., Centre National d'Etudes des Telecommunications, France; Fleury, R., Centre National d'Etudes des Telecommunications, France; Apr. 1996; 8p; In French; See also 19970000233; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes the influence of antennas and propagation on the behavior of H.F. digital communication links. We highlight the role of the antennas with the help of a signal model which takes into account the particularities of propagation in the H.F. range. Results of an experimental link are analyzed and we demonstrate the efficiency of a polarization filtering; this filtering procedure can also be viewed as a vector processing technique allowing a decrease of the BER.
Author
Communication Networks; Antennas; Wave Propagation

19970000281 Virginia Polytechnic Inst. and State Univ., Mobile and Portable Radio Research Group, Blacksburg, VA United States
SISP: A SOFTWARE TOOL FOR PROPAGATION PREDICTION
Koushik, Prabhakar M., Virginia Polytechnic Inst. and State Univ., USA; Rappaport, Theodore S., Virginia Polytechnic Inst. and State Univ., USA; Ahmed, Mansoor, Virginia Polytechnic Inst. and State Univ., USA; Zhang, Ning, Virginia Polytechnic Inst. and State Univ., USA; Digital Communications Systems: Propagation Effects, Technical Solutions, Systems Design; Apr. 1996; 14p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Accurate modeling of radio propagation characteristics in and around built-up urban environments is vital to the successful functioning of surveillance and tracking systems utilizing wireless technology. A vast majority of the software tools currently available to military and civilian users are based on very simple models with fairly limited accuracy and are closed architectures. We discuss the design and development of a software tool that provides: (1) a framework for modelers to incorporate new models and test their hypotheses, and (2) system designers and planners to obtain the propagation characteristics in any environment. The interactive software executes on a workstation, uses topographic maps with building overlays to predict signal coverage and channel characteristics for user-specified antenna locations. Work is in progress to improve the accuracy of the prediction software through better diffraction modeling.
Author
Computer Programming; Radio Transmission; Wave Propagation

19970000282 Hellenic Air Force Technology Research Center, Athens, Greece
HYBRID DIRECT SEQUENCE-FREQUENCY HOPPING CELLULAR SYSTEM
Kehagias, K., Hellenic Air Force Technology Research Center, Greece; Apr. 1996; 14p; In English; See also 19970000233; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The performance of a hybrid Direct Sequence - Frequency Hopping system for mobile communications is described through computer simulation results. The term hybrid implies the combination

of two separate systems operating together within the same physical channel and not a Direct Sequence (DS) signal whose center frequency hops periodically. The DS part supports the high data rate services and the Frequency Hopping (FH) part the low ones. Initially, a pure DS Code Division Multiple Access (CDMA) system is considered, capable of supporting data communications in a variety of bit rates. The capacity of this system (number of users in the allocated spectrum vs. bit error rate) is calculated. Consequently, low data rate services are removed from the DS system and are transmitted using a FH CDMA technique within the same bandwidth and for the same expected bit error rate performance. Overlapping and non-overlapping hopping patterns are considered. The overall (DS + FH) capacity is calculated and compared with the capacity of the pure DS system. The simulation model for the DS CDMA system is based on the specifications of CODIT (COde DIvision Testbed), a proposal for next generation's cellular communication system. For the FH CDMA the simulation model is based on a SFH system employing Phase Shift Keying (PSK) modulation.
Derived from text
Mobile Communication Systems; Data Transmission; Computerized Simulation

19970001709 Direction des Recherches, Etudes et Techniques, Radar Technologies Div., Paris, France
ELECTROMAGNETIC ANTENNA AND SMART STRUCTURES
Priou, A., Direction des Recherches, Etudes et Techniques, France; Oct. 1996; 6p; In English; See also 19970001697; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

One of the future applications of smart structures and materials for aircraft of new generation could be the electromagnetic smart skin antennas integrated on the aircraft. Military aircraft contains a proliferation of antennas to support advanced weapon system avionics. A tendency is to reduce the number of antennas sites on an aircraft to a minimum set of multifunction smart skin apertures that will provide equivalent or superior coverage and that will satisfy all the requirements of advanced weapon system avionics. Up to 50 % of the air vehicle could be used for embeddement of antennas. Controllable and reconfigurable antennas or conformal antennas are needed for mission flexibility and for reducing component failure or battle damage. Pay-offs are mainly cost saving and weight saving per aircraft with additional properties such as improved low observable performances, supportability and drag reduction, etc... In the first part of the presentation, we will review the present international activity in this area. We will develop some arguments to answering the question: why to do it? In the second part, we will introduce the concept of multifunctional smart skin antenna passing through the elementary radiating element, the adaptive antenna, and the antenna array. The electronic scanning and steering antenna array as well as the conformal antenna array is approached. We end the presentation by a concept of electromagnetic smart skin antenna array that can be developed in the future and integrated to military or civilian aircrafts. During this presentation, a lot of examples will be given for each case. We will address the critical enabling technologies required to implement an electromagnetic smart antenna. We will show the main advantages of such new technologies and concept for military aircraft of new generation (benefit and pay-offs).
Author
Smart Structures; Antenna Components; Antenna Arrays; Support Systems

19970006892 Massachusetts Univ., Microwave Remote Sensing Lab., Amherst, MA United States
MM-WAVE AIRBORNE CLOUD RADARS
Galloway, John, Massachusetts Univ., USA; Pazmany, Andy, Massachusetts Univ., USA; McIntosh, Robert, Massachusetts Univ., USA; Kelly, Robert, Wyoming Univ., USA; Vali, Gabor, Wyoming Univ., USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The demand for fine scale radar measurements of clouds from an airborne platform motivated the development of a 95 GHz imaging polarimeter used on a King Air research aircraft. The basic system components and operation of the polarimeter are discussed and the data processing techniques used to obtain conventional measurements of clouds obtained from a melting layer, mixed phase cloud, and marine stratus cloud during three different field experiments are provided with a description of flight and weather conditions prevailing during each observation.
Author
Airborne Radar; Meteorological Radar; Marine Meteorology; Imaging Techniques; Polarimeters; Hydrometers

19970006899 Naval Surface Warfare Center, Dahlgren, VA United States
DIRECT MEASUREMENT OF MICROWAVE PROPAGATION EFFECTS
Stapleton, J., Naval Surface Warfare Center, USA; Kang, S., Naval Surface Warfare Center, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The detection and tracking of low flying cruise missiles by shipboard radars is dominated by environmental effects. Significant temporal and spatial fluctuations in microwave propagation loss have been observed in this low altitude region. In order to better understand these fluctuations and to support the design and test of future naval radars, two microwave propagation measurement systems were developed which allowed the direct measurement of microwave propagation loss. Both systems concentrated on the low altitude region and made measurements at one frequency versus range and across a wide bandwidth for a fixed range. The test data presented in this paper gives a few examples which illustrate the variety of conditions sensed with these systems.
Author
Cruise Missiles; Environment Effects; Low Altitude; Radar Detection; Transmission Loss; Microwaves

19970006902 Naval Surface Warfare Center, Dahlgren, VA United States
USING REMOTE REFRACTIVITY TO PREDICT TROPOSPHERIC REFRACTIVITY FROM MEASUREMENTS OF MICROWAVE PROPAGATION
Boyer, Donald, Naval Surface Warfare Center, USA; Gentry, Greg, Naval Surface Warfare Center, USA; Stapleton, Janet, Naval Surface Warfare Center, USA; Burk, Stephen, Naval Research Lab., USA; Cook, John, Naval Research Lab., USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 14p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The direct measurements of vertical profiles of humidity and temperature at various ranges, from which range dependent refractivity structures are derived, are very difficult to obtain onboard a ship, and these profiles are needed in order to predict the performance of a radar system in a coastal marine environment. Recently remote sensing techniques have been proposed which attempt to deduce the refractivity structure over a path by measuring relative signal levels from known emitters. Since in a naval battle group there are known transmitters at different frequencies, whose signals can be monitored by any friendly ship, these radio propagation techniques offer high potential for implementation as part of a shipboard sensor assessment system. In order to derive refractivity fields in the lower atmosphere above the sea surface from measurements of propagation loss, the refractivity profiles must be represented in terms of a small number of parameters. This paper discusses using analytic representations of mean refractivity profiles in the constant flux surface layer of the marine atmospheric boundary layer. The numerical inversion techniques used for obtaining refractivity fields from measurements of propagation loss are also included.
Author
Air Water Interactions; Atmospheric Stratification; Coastal Water; Lower Atmosphere; Marine Environments; Microwaves; Ocean Surface; Radio Transmission; Remote Sensing; Surface Layers; Transmission Loss

19970006913 Crete Univ., Inst. for Telecommunication Systems, Crete, Greece
TARGET DETECTION VIA MEASUREMENTS TAKEN BY A TRANSMITTER-INDEPENDENT RECEIVER NETWORK
Farsaris, Nikos J., Crete Univ., Greece; Stavroulakis, Peter P., Crete Univ., Greece; Remote Sensing: A Valuable Source of Information; Oct. 1996; 14p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this paper, the technique of target detection via measurements of target range and Doppler shift taken by a set of cooperating radars in an area is extended for potential use on a transmitter independent receiver network (TIRN). This technique is explored for obtaining a detection system that comprises parameters that are substantial for military use: silent operation (undetectability) of an independent bistatic radar receiver, the accuracy of a monostatic radar, and the invulnerability of a distributed computer network.
Author
Computer Networks; Radar Receivers; Target Acquisition; Multistatic Radar; Doppler Effect

19970006917 Naval Command, Control and Ocean Surveillance Center, Propagation Div., San Diego, CA United States
ASSESSMENT OF NAM, THE NAVY AEROSOL MODEL, FOR VISIBILITY DETERMINATIONS IN INLAND SEAS SUCH AS THE PERSIAN GULF
Gathman, Stuart G., Naval Command, Control and Ocean Surveillance Center, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 6p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The effects of aerosol on the transmission of electro-optical energy in the marine atmosphere are very important. The propagation losses caused by aerosols at shipboard level over the open ocean regions of the world are adequately described by the Navy Aerosol Model (NAM). However, inland seas are very different in their geographical situations and the blind application of open ocean developed models to these regions is not necessarily applicable. The US Navy Sharem 110 exercise, which took place in the Arabian Gulf and the Gulf of Oman in February 1995, offered an excellent opportunity to investigate aerosol characteristics in these inland sea regions and compare the results to the open ocean situations as represented by NAM.
Author
Aerosols; Atmospheric Models; Electro-Optics; Visibility; Meteorological Parameters; Transmission Loss

19970006918 Naval Command, Control and Ocean Surveillance Center, San Diego, CA United States
SENSING ZERO-RANGE SURFACE SHIP INFRARED SIGNATURES
McGrath, Charles P., Naval Command, Control and Ocean Surveillance Center, USA; Zeisse, Carl R., Naval Command, Control and Ocean Surveillance Center, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Many imaging and non-imaging ship signature prediction codes exist, but few have been validated. In order to properly evaluate target signature and background prediction codes, an accurate database of radiometric images is required. This paper describes a method for acquiring radiometric images of marine targets and correcting the temperatures for atmospheric influences. Low cost remote sensing of infrared signatures is possible using a calibrated laboratory instrument like the AGEMA 900. by using a trusted atmospheric code, such as LOWTRAN or MODTRAN, corrections can be made. and by making remote measurements at two or more distances, the corrections can be fine-tuned to further improve accuracy.
Derived from text
Imaging Techniques; Infrared Signatures; Radiometers; Remote Sensing; Target Acquisition; Radiance; Image Processing

19970006919 Naval Command, Control and Ocean Surveillance Center, Propagation Div., San Diego, CA United States
RADIANCE OF THE WIND-RUFFLED SEA
Zeisse, C. R., Naval Command, Control and Ocean Surveillance Center, USA; McGrath, C. P., Naval Command, Control and Ocean Surveillance Center, USA; Littfin, K. M., Naval Command, Control and Ocean Surveillance Center, USA; Hughes, H. G., Science and Technology Corp., USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 12p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The important contributions to sea radiance are: (1) path emission, (2) sky reflection, (3) sun reflection, and (4) thermal black body emission. The spectral nature of each contribution can be understood from the infrared properties of the atmosphere and the ocean, and regularities among them can often be explained by Kirchoff's law. SeaRad, a computer model of sea radiance made by modifying MODTRAN2, takes source and path terms from that code, performs a statistical average over capillary wave slopes, and arrives at a prediction which agrees to within about 1 C with sea radiance measurements in the infrared.
Author
Black Body Radiation; Infrared Radiation; Thermal Emission; Radiance; Sea Roughness; Specular Reflection; Remote Sensing

19970006923 Defence Research Agency, Dept. of Space, Farnborough, United Kingdom
AUTOMATIC CHANGE DETECTION IN SPACEBORNE SAR IMAGERY
Corr, D. G., Defence Research Agency, UK; Whitehouse, S. W., Data Sciences (UK) Ltd., UK; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes new techniques for the automatic detection of change within synthetic aperture radar (SAR) images produced from satellite data. The interpretation of this type of imagery is difficult due to the combined effect of speckle, low resolution, and the complexity of the radar signatures. The change detection techniques that have been developed overcome these problems by automatically measuring the degree of change between two images. Changes within a time sequence of images (for example due to demolition or construction; damage, collection or dispersal of mobile assets) can then be determined by logic.
Author
Radar Signatures; Synthetic Aperture Radar; Radar Imagery; Remote Sensing; Earth Observations (From Space); Speckle Patterns

19970006925 Forschungsinstitut fuer Hochfrequenzphysik, Werthoven, Germany
ELECTRONIC COUNTERMEASURES AGAINST SYNTHETIC APERTURE RADARS
Kraemer, G., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Airborne and spaceborne synthetic aperture radars (SAR) are in use for remote sensing. to hide military targets from being detected by these systems, they might be attacked by electronic countermeasures (ECM). Since SAR systems are characterized by long-time coherent processing of echo signals with integration gains typically in the order of 80 dB, coherent jammers using digital radio frequency memories (DRFM) can generate false targets and camouflage patterns with only moderate jamming powers. The influence of a single coherent deception target, largely exceeding the normal radar echo power received from one single resolution cell, and the generation of a deceptive scene are studied with a simulation model of a generic airborne SAR.
Author
Electronic Countermeasures; Jamming; Radar Echoes; Remote Sensing; Signal Processing; Synthetic Aperture Radar; Airborne Radar

19970006927 GF-Sistemi Avionici, Turin, Italy
AIRBORNE SYSTEM DETECTION AND LOCALIZATION OF RADIO INTERFERENCE SOURCES
Audone, B., GF-Sistemi Avionici, Italy; Bresciani, F., GF-Sistemi Avionici, Italy; Novarese, F., Politecnico di Torino, Italy; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The theory of high resolution techniques used for direction finding is rather well established for fixed antennas. Theory of a system based upon the rotational invariance technique (ESPRIT) using a single pair of antennas in motion, such as happens in airborne installation, is described. The results of a simulated receiver system are also presented.
Author
Direction Finding; Radio Direction Finders; Invariance; Airborne Equipment; Antenna Arrays

19970006933 Centre d'Etudes et de Recherches, Toulouse, France
REVIEW OF MILLIMETER WAVE RADIOMETRY POTENTIALITIES: ACTIVITIES IN CERT-ONERA AND DLR-HF ***POTENTIALITES DE LA RADIOMETRIE EN ONDES MILLIMETRIQUES: ACTIVITES AU CERT-ONERA ET AU DLR-HF***
Lemorton, J., Centre d'Etudes et de Recherches, France; Suess, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Millimeter wave radiometry has been widely studied for more than twenty years now and can provide specific advantages as compared to infrared/visible imaging and radar detection as well. This paper presents a brief review of millimeter wave radiometry techniques and applications Recent advances microwave monolithic integrated circuit (MMIC) technology and in focal plane array imagers are particularly highlighted. Research work and CERT-ONERA and DLR-HF which have been active in the field for more than ten years are also described.
Author
Focal Plane Devices; Infrared Imagery; Radar Detection; Millimeter Waves; Remote Sensing

19970012579 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
MULTI-SENSOR MULTI-TARGET DATA FUSION, TRACKING AND IDENTIFICATION TECHNIQUES FOR GUIDANCE AND CONTROL APPLICATIONS ***LES TECHNIQUES DE POURSUITE ET D'IDENTIFICATION MULTI-CIBLES A BASE DE FUSION MULTI-SENSEUR APPLIQUEES AU GUIDAGE ET AU PILOTAGE***
Liang, David F., Editor, Department of National Defence, Canada; Butler, Steve, Editor, Advisory Group for Aerospace Research and Development, France; Garriga, Carlos, Editor, Advisory Group for Aerospace Research and Development, France; Mazzetti, Bruno, Editor, Advisory Group for Aerospace Research and Development, France; Uring, Thierry, Editor, Advisory Group for Aerospace Research and Development, France; Winter, Heinz, Editor, Advisory Group for Aerospace Research and Development, France; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996; 304p; In English; In French; See also 19970012580 through 19970012599
Report No.(s): AGARD-AG-337; ISBN 92-836-0031-2; Copyright Waived; Avail: CASI; A14, Hardcopy; A03, Microfiche

The aim of this AGARDograph is to provide a quick overview of practical advances in Multi-Sensor, Multi-Target Tracking (MS/MTT) technology and applications. In order that this AGARDograph could serve as a useful reference for those involved in the design, development, simulation, and applications of the techniques and technology, we have encouraged our authors to take, as much as possible, a tutorial approach. This will provide the general summary of the MS/MTT techniques and technology with emphasis towards practical implementation. Many examples of sensor fusion involve the methodology of merging various track files taken from different sensors. This allows for more consistent, accurate, and reliable tracks than might be possible with any of the individual systems acting alone. Section 1 relates to the important use of sensor fusion prior to establishing a firm track file. by combining raw sensor information, greater discrimination of targets from background may be possible from the augmented body of available information. Tracking and fusion with multiple sensors deals with integration and correlation of data from diverse sources in order to arrive at the best possible situational assessment. In Section 2, we present the tutorial on representative data association and filtering techniques, and also address some of the key initiation issues, approaches and track management methodology that simplify and enhance the practical implementation. Section 3 presents different types of classification algorithms, Bayesian Belief Networks, and Neural Networks covering the complete Automatic Target Recognition process, including fusion, segmentation and classification, that are very promising for real-time, or quasi-real-time systems applications. Section IV covers the handling of Automatic Target Recognition (ATR) test data, deals with an effective tool to support the development of precision guided munitions, and presents a study of target acquisition and sensor cueing in air-to-air environment. The last Section presents several practical examples of MS/MTT applications.
Derived from text
Multisensor Fusion; Target Acquisition; Multisensor Applications; Data Acquisition; Tracking (Position)

19970012580 Rome Lab., Griffiss AFB, NY United States
MULTI-FREQUENCY PHENOMENOLOGY FUSION VIA AN ULTRA-BROADBAND HYBRID SENSOR TECHNOLOGY ENHANCING SURVEILLANCE AND TARGET CLASSIFICATION/ID PERFORMANCE
Ogrodnik, Robert F., Rome Lab., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 3-13; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Target phenomenology has observables which occur across the electromagnetic spectrum, and, are linked in their multispectral characteristics through time in the multifrequency observation space, making target phenomenology an ideal candidate for detection domain level signal fusion. That is, given the ability to multispectrally observe target activity, as well as target phenomenon (i.e. missile multispectral launch transits, or, target vehicle body parts which may be dimensionally comparable with the surveillance wave length employed, etc.), an ideal surveillance approach, which supports detection domain fusion, would be to implement a broadband multispectrum surveillance sensor technology which could optimize its surveillance sensitivity and operating spectrum simultaneously on differing multispectral phenomena throughout the scenario life profile of the target. This paper addresses such a surveillance technology which exists today at Rome Laboratory. It is based on the integration of passive signal awareness monitoring combining real time signal parameter processing, and, passive coherent radar. This technology readily provides multispectral signal fusion by exploiting in real time background multiple ambient signal sources in order to synthesize a passive radar surveillance capability simultaneously at multiple carrier frequencies (as many diverse spectral sources as there are which constitute the electromagnetic ambient background in the target domain). This allows the target and its associated phenomena to be observed simultaneously in a multispectral fashion, optimizing detection performance whenever an optimal, or near optimal signal source is available for the purposes of enhanced detection and target classification.
Derived from text
Phenomenology; Carrier Frequencies; Broadband; Electromagnetic Spectra

19970012581 Naval Surface Warfare Center, Dahlgren Div., Dahlgren, VA United States
INTERACTIVE INTEGRATION OF PASSIVE INFRARED AND RADAR HORIZON SURVEILLANCE SENSORS TO EXTEND ACQUISITION AND FIRM TRACK RANGES
Horman, S. R., Naval Surface Warfare Center, USA; Stapleton, R. A., Naval Surface Warfare Center, USA; Hepfer, K. C., Naval Surface Warfare Center, USA; Headly, R. M., Naval Surface Warfare Center, USA; Stapleton, J. K., Naval Surface Warfare Center, USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 14-31; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The interactive integration of sensors has shown great promise as a means of significantly improving the range at which ships can detect and acquire high-speed, low altitude Anti-Ship Cruise Missiles (ASCM). Modest sensors, designed for the purpose, have been developed and successfully tested in a field environment. Near-horizon clutter was measured, producing some surprises. A real time integration system has been built and successfully field tested with sensors which had most of the desired characteristics against representative targets. In addition, an unprecidented capability has been developed to measure low altitude propagation to high fidelity as a function of frequency, time, target altitude, radar antenna height and target range, and to measure dynamic infrared refraction effects. This provided a dramatic means to better understand the performance of multi-sensor systems when operated in the field under conditions that produced

anomalous propagation. Improvements in firm track ranges were commensurate with our predictions. A FY95 real time demonstration is planned using a radar with an agile beam antenna.
Derived from text
Infrared Radar; Acquisition; Multisensor Applications; Surveillance; Targets; Character Recognition

19970012582 Pilkington Thorn Optronics, Hayes, United Kingdom
THE FUSION OF AN IR SEARCH AND TRACK WITH EXISTING SENSORS TO PROVIDE A TRACKING SYSTEM FOR LOW OBSERVABILITY TARGETS
Coates, P. V., Pilkington Thorn Optronics, UK; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 32-47; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This chapter covers the topic of the application of multi-sensor fusion, in a modern fighter aircraft, with the objective to improve the performance of pointing and tracking systems. It deals specifically with various techniques, including the use of other sensor ,data to improve the performance of a passive IR Search and Track (IRST) system to provide an enhanced tracking solution for targets at all ranges, from low observability long range stealth targets to short range pop-up targets. The timing is particularly appropriate in that Pilkington Thorn Optronics is the Technical lead partner in the European International Consortium responsible for the development of the IRST/FLIR system for Eurofighter 2000 (European Fighter Aircraft). It is one of the first airborne passive Electro Optic (EO) detection systems, in Development, capable of simultaneously detecting and accurately tracking multiple targets. It will also have a passive ranging capability. It will be the first time that such a high performance passive target acquisition and tracking system will be available in a modern fighter aircraft. The availability of such systems presents a unique opportunity to combine this information with other onboard sensing systems to obtain a performance 'force multiplier'.
Derived from text
FLIR Detectors; Infrared Tracking; Observability (Systems); Fuel Production

19970012583 Nichols Research Corp., Shalimar, FL United States
THE APPLICATION OF MMW/IR SENSOR FUSION TO TACTICAL US AIR FORCE WEAPON SYSTEMS
Watson, J. W., Nichols Research Corp., USA; Amphay, Sengvieng, Wright Lab., USA; Sundstrom, Bryce, Wright Lab., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 48-63; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The precision guidance of autonomous weapons to fixed High Value Targets (HVT's) and Critical Mobile Targets (CMT's) in high clutter backgrounds under adverse weather conditions represents one of the largest challenges facing the tactical Air Force weapons development community today. Such weapon systems will deny the enemy the cover of weather, just as infrared systems have eliminated the cover of night. One technology that is being explored as a means of addressing this Mission is Millimeter Wave (MMW)/Infrared (IR) sensor fusion. The Armament Directorate of the U.S. Air Force Wright Laboratory has been sponsoring research in the area of MMW/IR sensor fusion for tactical weapon systems since the mid 1 980's, much of which was accomplished under joint sponsorship with the U.S. Army Missile Command (MICOM). The purpose of this paper is to address the state of development of tactical Air Force MMW/IR sensor systems, and to demonstrate the results of current risk abatement efforts.
Derived from text
Millimeter Waves; Weapon Systems; Multisensor Fusion; Infrared Detectors; Utilization

19970012584 System Concept, Inc., Kanata, Ontario Canada
A PRACTICAL OVERVIEW OF MULTIPLE TARGET TRACKING ALGORITHMS
Lim, S. S., System Concept, Inc., Canada; Liang, D. F., Defence Research Establishment Ottawa, Canada; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 67-75; In English; See also 19970012579; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Multiple Target Tracking (MTT) in cluttered environments has been addressed in numerous military aerospace defence and civilian air traffic control studies. Most MTT methods employ models based on simplified assumptions. In this paper, a practical overview of three algorithms for MTT is presented: these are the Nearest-Neighbor (NN), Multiple Hypothesis Tracking (MHT), and Joint Probabilistic Data Association (JPDA) methods. The advantages and limitations of each technique are summarized and suggestions presented for implementation considerations. It should be noted that an efficient Modified MHT applied to Air Defence Tracking is also presented in this AGARDOGRAPH.
Derived from text
Algorithms; Multiple Target Tracking; Measuring Instruments

19970012585 Connecticut Univ., Dept. of Electrical and Systems Engineering, Storrs, CT United States
BALLISTIC MISSILE TRACK INITIATION FROM SATELLITE OBSERVATIONS WITH EXTRAPOLATION TO IMPACT
Yeddanapudi, Murali, Connecticut Univ., USA; Bar-Shalom, Yaakov, Connecticut Univ., USA; Pattipati, Krishna R., Connecticut Univ., USA; Deb, Somnath, Connecticut Univ., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 76-95; In English; See also 19970012579
Contract(s)/Grant(s): N00014-91-J-1950; F49620-95-1-0229; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This chapter presents an algorithm to initiate tracks of a ballistic missile in the initial exoatmospheric phase, using line of sight measurements from one or more moving platforms (typically satellites). The major feature of this problem is the poor target motion observability which results in a very ill-conditioned estimation problem. The Gauss-Newton iterative least squares minimization algorithm for estimating the state of a nonlinear deterministic system with nonlinear noisy measurements has been previously applied to the problem of angles-only orbit determination using more than three observations. A major shortcoming of this approach is that, convergence of the algorithm depends strongly on the initial guess. by using the more sophisticated Levenberg-Marquardt method in place of the simpler Gauss-Newton algorithm and by developing robust new methods for obtaining the initial guess in both single and multiple satellite scenarios, the above mentioned difficulties have been overcome. In addition, an expression for the Cramer-Rao lower bound on the error covariance matrix of the estimate is derived. We also incorporate additional partial information as an extra pseudo-measurement and determine a modified maximum likelihood estimate of the target state and the associated bound on the covariance matrix. In most practical situations, probabilistic models of the target altitude and/or speed at the initial point constitute the most useful additional information. Monte Carlo simulation studies on some typical scenarios were performed, and the results indicate that the estimation errors are commensurate with the theoretical lower bounds, thus illustrating that the proposed estimators are efficient.
Derived from text
Ballistic Missiles; Tracking (Position); Satellite Observation; Extrapolation; Targets

19970012586 Hughes Aircraft Co., El Segundo, CA United States
APPLICATION OF MULTIPLE HYPOTHESIS TRACKING TO MULTI-RADAR AIR DEFENSE SYSTEMS
Blackman, S. S., Hughes Aircraft Co., USA; Dempster, R. J., Hughes Aircraft Co., USA; Nichols, T. S., Hughes Aircraft Co., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 96-120; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This chapter discusses a multi-radar air defense system implementation that utilizes central-level observation (plot) processing and Multiple Hypothesis Tracking (MHT) data association. The chapter begins with an overview of the air defense system application and a discussion of the reasons MHT data association has been chosen. Next, the transformation of plot data from multiple distributed radars to a common stereographic coordinate system is described and the approach to registration is outlined. The mathematical basis and the implementation logic for the track-oriented MHT algorithm are

described. This includes a discussion of the clustering, pruning and merging methods that have been developed to make implementation feasible. The manner in which the output of the MHT tracker is presented to the user is also described. A number of features make the multi-radar air defense application more complex than single sensor systems. These include the variety and asynchronous nature of the input data, the potential for variable and heavy clutter densities and stringent false track confirmation requirements. This chapter will present the specific methods that have been developed to adapt the general MHT algorithms to these requirements. It will show how false track requirements can be related to the MHT track confirmation threshold through the use of the Sequential Probability Ratio Test (SPRT). Finally, analytic and simulation methods that have been developed and applied to predict performance of an air defense tracking system are discussed and representative results are presented.
Derived from text
Tracking (Position); Tracking Radar; Radar Equipment; Air Defense; Defense Program; Utilization

19970012587 George Mason Univ., Dept. of Systems Engineering, Fairfax, VA United States
MULTISENSOR TRACKING AND FUSION WITH MTI RADARS
Chang, Kuo-Chu, George Mason Univ., USA; Bar-Shalom, Yaakov, Connecticut Univ., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 121-129; In English; See also 19970012579 Contract(s)/Grant(s): N00014-91-J-1950; F49620-95-1-0229; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Multisensor tracking and data fusion deals with combining data from various sources to arrive at an accurate assessment of the situation. Technical difficulties m performing multisensor tracking and fusion include not only ambiguous data, but also disparate data sources The tracking and fusion problem is further complicated by the facts that targets may not be detected by some sensors, dense false alarms and clutter detections may be present, and the target model may not be known exactly. In this chapter, a multitarget tracking problem which involves data obtained from multiple MTI radars is considered. A tracking and fusion algorithm which takes into account the uncertainties in both data origin and target dynamics under a dense clutter environment is presented.
Derived from text
Tracking Problem; Multisensor Fusion; Targets

19970012588 Hughes Aircraft Co., Fullerton, CA United States
SYSTEM-LEVEL TRACK FUSION FOR COMMAND AND CONTROL
Dana, M. P., Hughes Aircraft Co., USA; Dana, J. L., Hughes Aircraft Co., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 130-146; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The central elements of this paper are the development of a statistical approach to the problem of track fusion, specifically, track correlation, and system track maintenance in distributed command and control systems. This paper presents: (1) the functional requirements for track management in conventional air defense systems and extended air defense systems (which include low-observable aircraft, cruise missile, and tactical ballistic missile defense); (2) the theoretical foundations for the sequential, multiple hypothesis decision processes used in the FAAD C(sup 2)I, IADS and NATO AEW Integration Programs; (3) track maintenance in distributed systems, and (4) a discussion of the practical aspects of the application of the theory to systems constrained by current data link message standards. The essential theory for sequential correlation decisions is based on the sequential probability ratio test for multiple alternative hypotheses. The decision statistics and criteria are derived together with the theoretical performance trade-offs among type 1 and type 2 errors and decision times.
Derived from text
Active Control; Statistical Analysis; Tracking Problem; Control Systems Design; Radar Tracking; Command and Control

19970012589 Office National d'Etudes et de Recherches Aeronautiques, Paris, France
CLASSIFICATION THROUGH COMBINING UNCERTAIN MULTIPLE-SENSOR DATA *CLASSIFICATION PAR FUSION DE DONNES INCERTAINES MULTI-SENSEURS*
Appriou, Alain, Office National d'Etudes et de Recherches Aeronautiques, France; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 149-160; In French; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper discusses a multiple-sensor analysis which is used to recognize one situation among a certain number of a priori identified hypotheses, for the identification of a target, for example, that must be capable of extracting the best part of all previously available learning. The traditional method of processing, especially probabilistic, still remain limited by the failure of representation of this learning sessions when the conditions of observation develop in a way that is not carefully controlled. In that case one must resort to uncertainty techniques, and in particular to the Theory of Evidence which will obtain the most open framework in this context. Its implementation, however, will lead to the delicate problem of interpretation of available information, considering the concepts that is allows one to deal with. Therefore it is an axiomatic search for the most pertinent solutions that we are suggesting here for two types of complementary problems, which are united by a generic processing concept for managing feasibility of the data that are supplied. The benefit of this approach is evaluated based on several simple simulations.
Derived from text
Classifications; Data Bases; Feasibility Analysis

19970012590 Lockheed Martin Palo Alto Research Lab., Palo Alto, CA United States
THE USE OF BAYESIAN BELIEF NETWORKS TO FUSE CONTINUOUS AND DISCRETE INFORMATION FOR TARGET RECOGNITION, TRACKING, AND SITUATION ASSESSMENT
Stewart, Leland, Lockheed Martin Palo Alto Research Lab., USA; McCarty, Perry, Jr., Lockheed Martin Palo Alto Research Lab., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 161-166; In English; Signal Processing, Sensor Fusion and Target Recognition, 21 Apr. 1992; Sponsored by International Society for Optical Engineering, USA; See also 19970012579; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper describes the use of Bayesian Belief Networks for the fusion of continuous and discrete information. Bayesian belief networks provide a convenient and straightforward way of modeling the relationships between uncertain quantities. They also provide efficient computational algorithms. Most current applications of belief networks are restricted to either discrete or continuous quantities. We present a methodology that allows both discrete and continuous variables in the same network. This extension makes possible the fusion of information from, or inferences about, such diverse quantities as sensor output, target location, target type or ID, intent, operator judgment, behavior profile, etc.
Derived from text
Target Recognition; Belief Networks; Tracking (Position)

19970012594 Nichols Research Corp., Shalimar, FL United States
THE MODULAR ALGORITHM CONCEPT EVALUATION TOOL (MACET) WORKSTATION
Watson, John, Nichols Research Corp., USA; Williams, Brad, Nichols Research Corp., USA; Talele, Sunjay, Nichols Research Corp., USA; Amphay, Sengvieng, Wright Lab., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 203-223; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Target acquisition in a high clutter environment in all-weather at any time of day represents a much needed capability for the air-to-surface strike mission. A considerable amount of the research at the Armament Directorate at Wright Laboratory, Advanced Guidance Division WL/MNG, has been devoted to exploring various seeker technologies, including multi-spectral sensor fusion, that may yield a cost efficient system with these capabilities. Critical elements of any such seekers are the autonomous target acquisition and tracking algorithms. These algorithms will allow the weapon system to operate inde-

pendently and accurately in realistic battlefield scenarios. In order to assess the performance of the multi-spectral sensor fusion algorithms being produced as part of the seeker technology development programs, the Munition Processing Technology Branch of WL/MN is developing an algorithm testbed. This testbed consists of the Irma signature prediction model, data analysis workstations, such as the TABILS Analysis and Management System (TAMS), and the Modular Algorithm Concept Evaluation Tool (MACET) algorithm workstation. All three of these components are being enhanced to accommodate multispectral sensor fusion systems. MACET is being developed to provide a graphical interface driven simulation by which to quickly configure algorithm components and conduct performance evaluations. MACET is being developed incrementally with each release providing an additional channel of operation. to date MACET 1.0, a passive IR algorithm environment, has been delivered. The second release, MACET 1.1 will be presented in this paper using the MMW/IR data from the Advanced Autonomous Dual Mode Seeker (AADMS) captive flight demonstration. Once completed, the delivered software from past algorithm development effort will be converted to the MACET library format, thereby providing an on-line database of the algorithm research conducted to date.
Derived from text
Algorithms; Evaluation; Workstations; Multisensor Fusion; Signature Analysis

19970012595 Alenia Aeronautica, System Technology Dept. T341, Turin, Italy
STUDIES AND SIMULATIONS ON SENSOR FUSION AND CUEING FOR FIGHTER APPLICATION
Avalle, Massimo, Alenia Aeronautica, Italy; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 224-232; In English; See also 19970012579; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A method to implement Sensor Fusion and Sensor Cueing on an advanced fighter aircraft is described in this paper. Starting from a short introduction concerning the general aspects and theory of Sensor Fusion, the paper presents some choices adopted during the development of the Sensor Fusion process at ALENIA AERONAUTICA System Technology dept. Sensor Cueing will be also introduced and some particular cases of interest for a fighter aircraft will be discussed. The performances of the adopted solutions are then discussed on the basis of some experimental results obtained using a simulation tool. An evaluation of the overall Sensor Fusion process performance and some considerations about possible alternatives will conclude the work.
Derived from text
Fighter Aircraft; Multisensor Fusion; Design Analysis; Product Development; Investigation

19970012596 Lim (S. S.), Kanata, Ontario Canada
AIR DEFENCE RADAR SURVEILLANCE SYSTEM TRACKING ASSESSMENT
Lim, S. S., Lim (S. S.), Canada; Liang, D. F., Defence Research Establishment Ottawa, Canada; Blanchette, M., Defence Research Establishment Ottawa, Canada; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 235-250; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In this paper, an efficient Multiple Hypothesis Tracking (MHT) algorithm has been developed and implemented. This algorithm is a modified version of MHT combined with an N-scan back pruning approach. The principal objective of this modification is to effectively reduce the large number of hypotheses in the original MHT thereby yielding a fast tracking algorithm which requires moderate computing resources. The modified MHT algorithm has been extensively tested against numerous sets of real radar measurements. These real radar data contain complex tracking scenarios such as trajectories of several fighter aircraft going through high-g maneuvers, crossing tracks and close formation in a cluttered environment. This paper will demonstrate the performance of the modified MHT algorithm against a set of real radar data. Descriptions of the radar data and the extent of the clutter are provided. The effectiveness of the modified MHT algorithm in handling maneuvering targets will also be discussed.
Derived from text
Air Defense; Radar Tracking; Surveillance Radar; Algorithms

19970012597 Alliant Techsystems, Inc., Hopkins, MN United States
LOW COST MULTI-SENSOR SUITES FOR SURVEILLANCE AND WEAPON GUIDANCE
Suresh, B. R., Alliant Techsystems, Inc., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 251-267; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

With the changing geo-political landscape, there is an ever increasing need for low-cost sensors for application to surveillance systems and weapon guidance. Typically, these applications require Mission Millimeter Wave (MMW) radars, IR imaging sensors, ladars and acoustic sensors as well as signal processing algorithms and high throughput miniature processors. The emphasis should be on developing low-cost individual sensors. The system applications then typically involve a suite of low-cost multiple sensors. The fusion of information from these sensors provides superior performance and an overall cost-effective product.
Derived from text
Multisensor Applications; Low Cost; Surveillance; Weapons Development; Guidance (Motion); Millimeter Waves

19970012598 British Aerospace Defence Ltd., Military Aircraft Div., Warton, United Kingdom
SENSOR DATA FUSION FOR AIR TO AIR SITUATION AWARENESS BEYOND VISUAL RANGE
Noonan, C. A., British Aerospace Defence Ltd., UK; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 268-283; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The modern air superiority aircraft is faced with ever increasing threats and more capable targets. to be effective against them, it needs to know what and where they are as early as possible during any encounter. It must do this during day and night, in all weathers, in hostile counter measure environments and in the presence of clutter. The aircraft will receive large amounts of information from multiple sensors and data communications systems. If the information is to be used effectively to the benefit of the mission, it must be aligned, correlated, consolidated and presented to the crew in a meaningful form. A model is offered of tactical situation awareness processing as it might be embedded in a future avionics system. It shows Sensor Data Fusion in relation to sensors and communications, to situation and threat assessment and to sensor and mission management. It shows the flow of data around the sub-system as it creates and maintains the tactical situation database and ranks the information therein in order of importance to the mission. The requirements placed on sensor data fusion by air superiority operations are discussed. These are dominated by particular features of the tactical aircraft platform and its mission. A computer test harness, developed by BAe Defence, Military Aircraft Division, is described, along with built in tools which calculate test statistics. The harness was developed as part of a programme of studies carried out by the Mission Systems group of the Product R&D team within the Systems Engineering Department at BAe's Warton unit in Lancashire, U.K. Examples of the results which were obtained when an air to sensor data fusion model was evaluated are reproduced.
Derived from text
Data Transmission; Air to Air Missiles; Multisensor Fusion; Data Bases; Attack Aircraft

19970018641 Daimler-Benz Aerospace A.G., Sensorsysteme, Ulm, Germany
HIGH PERFORMANCE DATA LINK FOR UNMANNED AIR-VEHICLES
Rochus, Wolfgang W., Daimler-Benz Aerospace A.G., Germany; Garcia, Dominique, Matra Cap Systemes, France; Nov. 1996; 10p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

As a result of various system studies and work on experimental and operational Data-Links for UAV and missile applications, MATRA CAP SYSTEMS of France and Daimler-Benz Aerospace AG 'SENSOR SYSTEMS GROUP' of Germany are cooperating for the development of a high performance Data-Link for a franco-german UAV system. The organization formed for the development of this Data-link comprises a joint system engineering team for refinement of

the overall data link design, definition of interface and specification of requirement to ground data terminal and air data terminal. Separate project teams in the two companies. One company responsible for ground station development, one company for development of airborne station. Maximum commonality by using identical sub-components in both stations as far as possible. Joint program direction comprising the program managers of both companies. Based on the system work, which was done in the two companies in order to win that development contract and the knowledge of previous data links which are in development or production for missile systems, the subject of data links for UAV applications is presented here.
Derived from text
Data Links; Aerospace Systems; Pilotless Aircraft

19970026375 Aerospatiale, Dept. Aerodynamique and Electromagnetisme, Les Mureaux, France
COMMUNICATION BLACKOUT DURING EARTH-ATMOSPHERE ENTRY OF CAPSULES
Boukhobza, M., Aerospatiale, France; May 1995; 8p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Communication blackout that occurs when space capsules enter the earth atmosphere is discussed. This paper has three sections. The first section describes: the communication blackout phenomenology, computer programs used at Aerospatiale Espace & Defence to predict the plasma characteristics, and the radioelectric attenuations effects in communication blackout. The second section deals with altitude ranges and encountered problems during the atmosphere entry of capsules. Examples of communication blackout observed during entry of APOLLO and SOYOUZ vehicles are summarized in the last section.
CASI
Atmospheric Entry; Blackout (Propagation); Plasma Sheaths; Reentry Communication; Boundary Layer Plasmas; Space Capsules; Hypersonic Reentry; Aerodynamic Heating

19970026380 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
AUDIO EFFECTIVENESS IN AVIATION *L'EFFICACITE DES COMMUNICATIONS VOCALES EN AERONAUTIQUE*
Audio Effectiveness in Aviation; Jun. 1997; 370p; In English; In French, 7-10 Oct. 1996, Copenhagen, Denmark; See also 19970026381 through 19970026417
Report No.(s): AGARD-CP-596; ISBN 92-836-0043-6; Copyright Waived; Avail: CASI; A16, Hardcopy; A03, Microfiche

These proceedings include the Technical Evaluation Report, a Keynote Address, three overview addresses of key technical areas, 34 solicited papers, and a Summary paper of the Symposium sponsored by the AGARD Aerospace Medical Panel held in Copenhagen, DE, from 7-11 October 1996. Topics addressed during this Symposium were: Audio Displays Noise Control, Passive Technique Noise Control, Active Technique Noise Control, Applications Communication in Stressful Environment, and Voice Control.
Author
Aerospace Medicine; Conferences; Noise Reduction; Voice Communication; Human Factors Engineering; Aircraft Noise; Cockpits; Voice Control; Auditory Perception

19970026381 Defence Research Agency, Systems Integration Dept., Farnborough, United Kingdom
THE AUDIO ENVIRONMENT IN AIRCRAFT
Rood, Graham, Defence Research Agency, UK; Jun. 1997; 10p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The overall aim of much of the Acoustic & Noise research is to minimize the risk of hearing damage whilst maximizing the operational communications capability, with communications meaning all necessary signals to the pilots' ear. Calculations show that by using next generation active noise reduction technology in the flying helmet, producing higher levels of active reduction or combinations of active & passive attenuation, it is possible to reduce the noise levels at the pilots ear to around 75 dB, such that the hearing damage risk is essentially reduced to zero. The reduction of noise levels at the ear is also fully compatible with improving speech & non-speech communications. At the talker & signal input end - at the microphone - signal processing approaches are needed to provide adequate signal to noise ratios for transmission, not only for the reception by humans, but also for the recognition by machines, whether they are part of a human centered system (e.a. Vocoder) or a machine centered system (e.g. Voice Recognition Systems). At the listening end, research into means of noise reduction, either active or passive - or, more likely, and tested Auditory Icons, will require the use of higher quality transducers in the helmet earshell, as will the use of good performance ANR, and this will support the move towards higher speech intelligibility. Overall, the progress of technology and computing, that is now available in the acoustics arena, will provide a strong capability to allow the enhancement of operational crew performance by the use of the auditory mode as a synergistic supplement to the more heavily utilized visual senses.
Derived from text
Noise Reduction; Auditory Perception; Human Factors Engineering; Aerospace Medicine; Aircraft Noise; Voice Communication; Cockpits; Pilots (Personnel); Helmets; Noise Intensity; Ear Protectors

19970026384 Wright State Univ., Dept. of Psychology, Dayton, OH United States
DESIGN CONSIDERATIONS FOR 3-D AUDITORY DISPLAYS IN COCKPITS
Gilkey, Robert H., Wright State Univ., USA; Simpson, Brian D., Wright State Univ., USA; Isabelle, Scott K., Armstrong Lab., USA; Anderson, Timothy A., Armstrong Lab., USA; Good, Michael D., Honeywell Technology Center, USA; Jun. 1997; 10p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Potential cockpit applications of 3-dimensional auditory displays have generated considerable interest. These applications include: increasing speech intelligibility by spatially separating communication channels, providing a navigation beacon, directing pilots' attention to targets and threats, enhancing situational awareness by cuing a wingman's location or indicating an imminent collision, or even providing an auditory attitude indicator. However, cockpit noise and the complexity of the signals to be localized can adversely affect sound localization performance and may limit the effectiveness of these displays. We review the results of our experiments on sound localization in noise and the localization of speech signals with the head stationary, which indicate that although the ability to distinguish left from right can be quite accurate in adverse situations, often the accuracy of elevation judgments decreases and the number of front/back confusions increases with relatively small deviations from ideal conditions. The implications of these performance limitations for the design of auditory displays and potential strategies for enhancing performance will be discussed.
Author
Aircraft Pilots; Sound Localization; Auditory Perception; Cockpits; Display Devices; Position (Location); Voice Communication; Noise Reduction

19970026385 Sextant Avionique, Saint Medard en Jalles, France
PERCEPTUAL AND COGNITIVE SYNERGY IN TARGET ORIENTATION: 3D SOUND AND VISUAL INFORMATION *SYNERGIE PERCEPTUELLE ET COGNITIVE DANS L'ORIENTATION VERS UNE CIBLE: SON 3D ET INFORMATION VISUELLE*
Courneau, M., Sextant Avionique, France; Leppert, F., Sextant Avionique, France; Gulli, C., Sextant Avionique, France; Leger, A., Sextant Avionique, France; Pellieux, L., Centre d'Enseignement et de Recherches de Medecine Aeronautique, France; Haas, M., Armstrong Lab., USA; Jun. 1997; 6p; In French; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In the experimentation described here, two types of information that can make it possible to locate a threat were studied in an aeronautical context. Visual information, consisting of an arrow pointing toward the threat, involving a relatively high-level cognitive mechanism, was presented on an HMD (fully feathering propeller). A more perceptual location aid, based on 3D sound, was used alternatingly or simultaneously. The study was conducted in the context of cooperation between Sextant Avionique, Armstrong Laboratory, and IMASSA/CERMA. The purpose was to evaluate the effectiveness of these two modes of information in a flight simulator and to test the hypothesis of a synergy between them. The results presented here relate more particularly to the phase of orientation toward the threat. The analysis of data received during the experiment shows that the visual and sound information is equivalent and that there is an additive synergy.

This synergy is revealed by a significant improvement of the performances of the test subjects when the two modes are presented in an additive and simultaneous fashion.
Transl. by Schreiber
Flight Simulators; Target Acquisition; Position (Location); Visual Perception; Audio Equipment; Noise (Sound); Auditory Perception

19970026386 Institute for Human Factors TNO, Soesterberg, Netherlands
EVALUATION OF A THREE-DIMENSIONAL AUDITORY DISPLAY IN SIMULATED FLIGHT
Bronkhorst, A. W., Institute for Human Factors TNO, Netherlands; Veltman, J. A., Institute for Human Factors TNO, Netherlands; Jun. 1997; 6p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Modern signal processing techniques allow headphone sounds to be processed in such a way that they seem to originate from virtual sound sources located in the three-dimensional space around the listener. by using head tracking devices, it is even possible to create a stable virtual acoustic environment that takes (head) movements of the listener into account. One interesting application of 3D sound is that it can be used to support situational awareness by generating virtual sound sources that indicate positions of relevant objects (e.g. targets or threats). This application was investigated in two flight simulation experiments in which the 3D auditory display, used as a radar display, was compared with 2D and 3D visual radar displays. A target localization task was employed, in which the subject, who flew a fighter aircraft, had to locate and follow another, suddenly appearing aircraft as quickly as possible. Dependent variables were the search time and a subjective workload score, obtained after each trial. In the second experiment, also the deviation from the optimal track toward the target and the performance on a secondary task were scored. Results show that search times and workload are similar for 3D auditory and 2D visual displays. Search times for the 3D visual display were smaller. Simultaneous presentation of auditory and visual displays gave clearly improved performance in case of the 2D visual display, but only minimal improvement with the 3D visual display. The results demonstrate the effectiveness of a 3D auditory display used as a radar display, but indicate that further development is required to reach the performance level of advanced 3D visual displays.
Author
Earphones; Display Devices; Fighter Aircraft; Flight Simulation; Noise (Sound); Auditory Perception; Signal Processing; Man Machine Systems; Cockpits; Sound Generators

19970026387 Armstrong Lab., Crew Systems Directorate, Wright-Patterson AFB, OH United States
FLIGHT DEMONSTRATION OF AN INTEGRATED 3-D AUDITORY DISPLAY FOR COMMUNICATIONS, THREAT WARNING, AND TARGETING
McKinley, Richard L., Armstrong Lab., USA; DAngelo, William R., Armstrong Lab., USA; Ericson, Mark A., Armstrong Lab., USA; Jun. 1997; 14p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Recent laboratory experiments have demonstrated significant increases in visual target acquisition performance when the subjects have been aided by 3-D audio cueing. The USAF Armstrong Laboratory's 3-D audio display system was integrated with a helmet mounted display system on a Navy/Marine TAV-8B Harrier for a joint Air Force/Navy flight demonstration. The 3-D audio system has the capability of synthesizing signals that when presented over headphones give the user the illusion that the sound is emanating from some external location. These synthesized signals can be configured to emanate from selected known sources to indicate their location on the ground and in the air. Military aircraft applications of 3-D audio include threat location warning, wingman location indication, spatially separated multichannel communications, and audio target location indications. For this flight demonstration, the Armstrong Laboratory 3-D audio system implemented spatially separated communications, threat location cueing, and target location aiding. Laboratory experiments of combined audio-visual search performance resulted in target acquisition time reductions of approximate 50 percent and workload reductions of approximately 20 percent. In March 1996, the data collection portion of the flight demonstration was initiated. The integration of the 3-D audio system into the TAV-8B, the laboratory experimental results, and the preliminary results of the flight demonstration are presented in addition to recommendations for future research and flight tests.
Author
Multichannel Communication; Audio Equipment; Voice Communication; Sound Transmission; Target Acquisition; Helmet Mounted Displays; Flight Tests; Display Devices; Auditory Perception; Human Factors Engineering

19970026407 Institute for Human Factors TNO, Soesterberg, Netherlands
COORDINATED SPEECH TECHNOLOGY RESEARCH OF NINE NATO COUNTRIES IN RESEARCH STUDY GROUP RSG.10
Steeneken, H. J. M., Institute for Human Factors TNO, Netherlands; Gagnon, L., Department of National Defence, Canada; Jun. 1997; 6p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The relevance of the application of speech and language technology in the military is considered. The Research Study Group initiates and coordinates research on these applications, focused on the specific adverse military conditions. Specifically multi-lingual applications with non-native speakers, adverse environmental conditions (high noise, g-forces, vibration), and stress conditions (workload, battlefield) do reduce the performance of advanced applications. For example secure voice at low bit-rates, speech recognition in command and control, speaker/language recognition for intelligence and translation in joint force conditions are major applications to be studied. Nine NATO countries participate in this effort.
Author
Command and Control; North Atlantic Treaty Organization (NATO); Speech Recognition; Languages

19970026408 German Air Force, Otorhinolaryngology Dept., Fuerstenfeldbruk, Germany
SPEECH LANGUAGE HEARING TEST RESULTS OF ACTIVE DUTY PILOTS FAILING THE PURE TONE AUDIOMETRY LIMITS OF ICAO GUIDELINES: METHOD, PROBLEMS AND LIMITS TO VERIFY THE WAIVER STATUS
Hanschke, W., German Air Force, Germany; Jun. 1997; 4p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Adequate hearing is essential for communication in flight and rapid and accurate assessment of warning tones in the cockpit. Waiver is permitted, when hearing is adequate to permit essential communication in flight. The Freiburger speech language hearing test method gives the opportunity to verify the intelligibility in a standard proven manor with the possibility to add aviation related necessities. A higher safety standard could be refined by replacement of the former subjective aeromedical hearing methods.
Author
Audiometry; Speech Recognition; Voice Communication; Aircraft Pilots; Hearing; Noise Reduction; Auditory Perception; Languages; Auditory Defects

19970026409 Royal Norwegian Air Force, Inst. of Aviation Medicine, Oslo, Norway
IMPROVED SPEECH INTELLIGIBILITY IN AIRCRAFT NOISE DUE TO ALTITUDE
Wagstaff, Anthony S., Royal Norwegian Air Force, Norway; Jun. 1997; 6p; In English; See also 19970026380; Sponsored in part by Norwegian Air Ambulance; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Few studies have addressed effects of altitude and noise combined, although these two effects are inherent parts of all aviation. The few published studies that have addressed altitude effects on hearing function have mainly focused on using gas mixtures, and have demonstrated inconclusive results. The present study was designed to assess the effect of altitude on speech intelligibility in aircraft noise. The primary hypothesis was a predicted detrimental, hypoxic effect on speech intelligibility in noise. Eight male subjects with normal hearing were fitted with an aviation headset specially adapted for use with the audiometer. Pure-tone audiometry, as well as speech audiometry in noise, was performed at 0, 10,000, 13,000, and 16,000 ft. simulated altitudes in a hypobaric chamber. The 4 test altitudes were performed double blind with respect to audiometry operator and test subject. Arterial blood gases where measured using an intra-arterial catheter and

tympanometric measurements verified full middle ear equilibration. Noise levels where monitored and logged throughout all experiments. A substantial increase in speech intelligibility in noise due to altitude was found in this study. The physical effect of barometric pressure on noise causing an increased signal-to-noise ratio was found to greatly outweigh any hypoxic detrimental effect.
Author
Aircraft Noise; Noise Intensity; Auditory Perception; Voice Communication; High Altitude Environments; Aerospace Medicine; Speech Recognition; Earphones; Hearing

19970026410 Armstrong Lab., Bioacoustics and Biocommunications Branch, Wright-Patterson AFB, OH United States
VULNERABILITY OF FEMALE SPEECH PRODUCED IN OPERATIONAL NOISES
Nixon, C. W., Armstrong Lab., USA; Morris, L. J., Armstrong Lab., USA; McCavitt, A. R., Armstrong Lab., USA; McDaniel, M. P., Armstrong Lab., USA; Anderson, T. R., Armstrong Lab., USA; McKinley, R. L., Armstrong Lab., USA; Yeager, D. G., Armstrong Lab., USA; Jun. 1997; 12p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This study quantified the speech intelligibility differences in high level noise due to gender. Female speech was always less intelligible than male speech and the differences grew with increased levels of the noise. Intelligibility of both male and female speech differed with aircraft noise spectrum. These gender differences caused no impact at the lower levels of noise, however they do constitute a problem at the highest levels. The application of active noise reduction technology and replacement of the M-87 with the M-169 noise canceling microphone should neutralize most of these impacts. The perception of LPC-10 and CVSD vocoded female speech was essentially the same as male speech. There were no significant differences between the recognition accuracy of male and female speech for either the ITT or IBM automatic speech recognition system.
Author
Speech Recognition; Sex Factor; Females; Aircraft Noise; Noise Reduction; Voice Communication; Noise Intensity

19970026411 Armstrong Lab., Bioacoustics and Biocommunications Branch, Wright-Patterson AFB, OH United States
A VOICE COMMUNICATION EFFECTIVENESS TEST
McKinley, Richard L., Armstrong Lab., USA; Moore, Thomas J., Armstrong Lab., USA; Nixon, Charles W., Armstrong Lab., USA; Jun. 1997; 14p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A Voice Communication Effectiveness Test (VCET) was developed for relating voice communications performance to the effective completion of tasks with varying complexity, criticality, and time constraints. VCET is based on information theory and was initially developed for military applications. This metric accounts for the information required for task completion, the time available for the task, and the criticality or cost of an error relating to the quality of the communication channel. It can quantify the effects of competing workload on voice communications and it encompasses a wide range of voice communications systems and equipment, noise environments, and military missions. The rationale, development, and performance of these powerful analytical tools with applications in both the military and civilian communities were described. VCET shows great promise as the first true voice communication effectiveness test measuring not only intelligibility, but also information transfer with or without time dependency.
Author
Voice Communication; Information Transfer; Information Theory; Auditory Perception

19970026412 MRC Applied Psychology Unit, Cambridge, United Kingdom
VOCAL AGITATION AS A PREDICTOR OF EMOTION AND STRESS
Allerhand, M. H., MRC Applied Psychology Unit, UK; Patterson, R. D., MRC Applied Psychology Unit, UK; Jun. 1997; 10p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper reports an application of a computational auditory model to measure vocal agitation in speech automatically, and to relate it to the perceived stress in recordings of pilots operating under adverse conditions. Results of a short-time correlational experiment show significant correlation ($r = 0.765$; p is less than .001) between measured and perceived vocal agitation. It is also shown that time-integrated vocal agitation corresponds well with perceived stress over a period of the order of 18s.
Author
Voice Communication; Auditory Perception; Mathematical Models; Aircraft Pilots; Acoustics; Aircraft Noise; Agitation

19970026413 Defence Research Agency, Systems Integration Dept., Farnborough, United Kingdom
EFFECTS OF HELICOPTER CABIN NOISE UPON HF VOCODER SECURE SPEECH SYSTEMS
Rogers, I. E. C., Defence Research Agency, UK; Rood, G. M., Defence Research Agency, UK; Jun. 1997; 10p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

An increasing number of military aircraft are being provided with secure (encrypted) systems for air-to-air, air-to-ground and ground-to-air communications. Most secure HF radio channels use a Linear Predictive Coder (LPC-10 Vocoder) to parameterize the talker's speech, and this digital data is then encrypted before being transmitted over the HF radio link. At the receiver, the data is decrypted and fed into a second vocoder, where the speech parameters transmitted are used to produce a representation of the original speech signal. The vocoders transmit the digitized data at 2.4kbits/sec according to the NATO STANAG 4198 interoperability standard. Studies at DRA Farnborough have identified that the presence of helicopter noise at the microphone input to the transmitting vocoder reduces the intelligibility of the vocoded speech transmitted, and that the reduction is dependent on the relative levels of the speech and noise at the microphone (i.e. the speech to noise ratio, SNR). These assessments have been conducted using Diagnostic Rhyme Test (DRT) techniques. DRA have investigated techniques to enhance the performance of vocoders using digital processing techniques. DRT and user acceptability assessment trials have been conducted to assess the effects of these techniques on LPC-10 vocoder performance and the results of this work will be presented.
Author
Military Aircraft; Aircraft Noise; Digital Data; Helicopters; Aircraft Compartments; Voice Communication; Noise Reduction; Vocoders; Radio Communication; Voice Data Processing

19970026415 Defence Research Agency, Systems Integration Dept., Farnborough, United Kingdom
VOICE RECOGNITION IN ADVERSE AIRCRAFT COCKPIT ENVIRONMENTS
South, A. J., Defence Research Agency, UK; Jun. 1997; 10p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A speech recognition system has been flown in a two seat Tornado strike aircraft and assessments made of the recognition accuracy under normal, terrain following and 4G turning flight. Word accuracies averaged some 96% under normal flight, and 95% under terrain following. During 4G turns the recognition levels dropped to around 80%. Subsequent speech recordings made on the centrifuge at the RAF School of Aviation Medicine consisted of lists of digit strings and typical Direct Voice Input command phrases. Recordings were made at up to 8G, using four different levels of anti-G protection. The subjects were five male RAF personnel, and one female. The digit string lists were used to test a speaker-dependent whole word speech recognizer at up to 6G. The results will be presented for protection using standard and full coverage anti-G garments, and with the use of positive pressure breathing. Possible solutions to the lower accuracy rates at higher G levels and with pressure breathing are discussed.
Author
Speech Recognition; Military Aircraft; Aircraft Pilots; Auditory Perception; Voice Communication; Cockpits; Gravitational Physiology; Gravitational Effects

19970026416 Wright Lab., Vehicle-Pilot Integration Branch, Wright-Patterson AFB, OH United States
FLIGHT TEST PERFORMANCE OPTIMIZATION OF ITT VRS-1290 SPEECH RECOGNITION SYSTEM
Williamson, David T., Wright Lab., USA; Barry, Timothy P., Wright Lab., USA; Liggett, Kristen K., Wright Lab., USA; Jun. 1997; 6p; In English;

See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper discusses the performance optimization of an ITT VRS-1290 continuous speech, speaker dependent speech recognition system that was flight tested in a NASA Lewis Research Center OV-10A aircraft. A 53-word vocabulary was tested with twelve pilots using an M-162 microphone headset on the ground and under 1g and 3g flight conditions. Digital Audio Tape (DAT) recordings were made of both the subjects' input and ambient background noise. Noise levels in the rear cockpit were in excess of 115 dB, with signal-to-noise ratios measured as low as 12 dB. During the early stages of the flight test, performance of the ITT system was poor, with some subjects achieving below 60% recognition accuracy. The DAT recordings became a critical element in the troubleshooting and optimization of the ITT system. A combination of input gain. noise calibration, and ITT recognizer engineering parameters were adjusted based on DAT testing to achieve an average word accuracy of 97.7% in the 1g condition and 97.1% in 3g across all subjects.

Author

Speech Recognition; Flight Tests; Gravitational Effects; Background Noise; Flight Conditions; Microphones; Voice Communication; Aircraft Pilots; Earphones

19970026417 Abertay Univ., Div. of Psychology, Dundee, United Kingdom

HIDDEN USABILITY ISSUES IN SPEECH INTERFACES

Cook, Malcolm J., Abertay Univ., UK; Cranmer, Charles, Abertay Univ., UK; Milton, Carol-Ann, Abertay Univ., UK; Finan, Robert, Abertay Univ., UK; Sapeluk, Andy, Abertay Univ., UK; Jun. 1997; 30p; In English; See also 19970026380; Sponsored in part by European Social Fund; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The increasing power and sophistication of speech recognition and speech synthesis has encouraged speculation that human factors problems in implementing speech interfaces will diminish dramatically as technological develops. Advanced speech interfaces have been investigated and are currently being integrated into prototypes for advanced civil and military cockpits. The reason for the introduction of speech-based interfaces is to increase the time available for head-up flight and, thereby, to improve flight performance and safety. The advantage which is claimed for delivering information via speech-based interfaces is a reduction the vast quantities of information normally presented in visual displays in the cockpit and the release of the pilot from head down management of cockpit systems. Directly or indirectly, the benefits of splitting information delivery and data command/entry across modalities are often justified in terms of independent information processing. The independent nature of the processing in turn assumes there will be no interference between tasks or degradation in performance. Pilot research by the authors indicates that there are problems related to memory and workload that are present in current technology and will remain in future solutions with speech-based interfaces. These problems will remain in even though recognition accuracy is increased because they reside in the limits of the human operator to manage multi model environments. In a simulated multi-task environment self-reports and performance a moderate to high levels workload workload with multi-model interfaces have shown that overall performance with speech-based interfaces is degraded. The use of multi-model interfaces resulted in degraded performance on tasks requiring extended processing of information and recall of information from memory.

Author

Speech Recognition; Voice Communication; Aircraft Instruments; Voice Control; Cockpits; Display Devices; Man Machine Systems

19970026420 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Hochfrequenztechnik, Oberpfaffenhofen, Germany

POSSIBILITIES AND LIMITATIONS OF SPACEBORNE SAR WITH RESPECT TO MILITARY RECONNAISSANCE

Keydel, W., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Jun. 1997; 10p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

SAR systems for military applications have to be considered with respect to the requirements resulting from specific scenarios which are estimated by the objects to be observed. The most important requirements for military reconnaissance satellites are the geometrical resolution, the dimension of the covered area as well as timelining and the coverage repetition. The latter is strictly dependent on the satellites orbit, which leads to power requirements. Synthetic aperture radar systems have potential resolution capabilities nearly comparable with optical systems. The image resolution as well as its contrast is dependent on weather conditions and optical vision. Foliage penetration, principally, is possible and lower frequencies allow to some extent surface penetration also. Main restrictions of SAR are related to data processing, data handling and power requirements. Automatic real time image analysis as well as image interpretation is not yet possible at all. However, special modes like Scan-SAR, Interferometry, Look Steering and Spot Light, as well as multi mode and multi satellite concepts seem to be able to overcome many limitations and to increase the efficiency of SAR systems for military purposes drastically.

Derived from text

Synthetic Aperture Radar; Military Technology; Military Spacecraft; Real Time Operation; Reconnaissance; Spacecraft Design

19970026422 GEC-Marconi Research Centre, Great Baddow, United Kingdom

RADAR BACKSCATTER STATISTICS FROM THE SEA SURFACE: IMPLICATIONS OF SIR-C/X-SAR OBSERVATIONS FOR MARITIME SURVEILLANCE

Macklin, J. T., GEC-Marconi Research Centre, UK; Stapleton, N. R., GEC-Marconi Research Centre, UK; Robertson, N. A., Defence Research Agency, UK; Ringrose, R., Defence Research Agency, UK; Jun. 1997; 8p; In English; See also 19970026418

Contract(s)/Grant(s): DRA-CSM2/155; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Multi-channel synthetic-aperture radar (SAR) observations from the SIR-C/X-SAR experiment in the N. E. Atlantic (April 1994) are analyzed, to test models of both the mean and the distribution of radar backscatter from the sea surface. The data cover incidence angles from about 20 deg to 40 deg, and wind speeds from about 5 to 10 m s(exp 1). Empirical and theoretical models of the mean fit the data well at C band, to an accuracy of 1 - 2 dB. Discrepancies at L and X bands point to needs for better empirical models at these frequencies, and for modifications to existing descriptions of short-wave spectra in theoretical models. Single-look SIR-C/X-SAR data (spatial resolution approximately 7 - 10 m) fit well to a K distribution, but multi-look data (spatial resolution approximately 25 m) fit a lognormal distribution. The observed second moments can be explained by the modulations of resolved ocean-surface waves, but only if relatively large hydrodynamical modulations are assumed. Swell-wave modulations are sometimes significantly larger at X band than at C and L bands. The implications of these results for the false-alarm rates in marine-target detection are discussed.

Derived from text

Synthetic Aperture Radar; Target Acquisition; Surveillance; Ocean Surface; Backscattering; C Band

19970026423 Alenia Spazio S.p.A., Rome, Italy

POSSIBLE FEATURES OF NATO COMMUNICATIONS SATELLITE GAP FILLER

Ricci, P., Alenia Spazio S.p.A., Italy; Franzosi, A., Alenia Spazio S.p.A., Italy; Jun. 1997; 10p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

NATO strategy is changed and emphasis is now on Multinational Groups, Mobile and Rapid Reaction Forces which are easily deployable in the crisis area and capable of rapid responses. In the new political scenarios, satellites are the only assets which can provide the timely and reliable communications required to exercise the command and control of deployed forces. It is also clear that space is the fourth component of a military operation and the role of communication satellites is of crucial importance for peace keeping, peace making operations and for the conduct of conflicts in areas where ground communications facilities can not be easily set up or are not any longer available. NATO communications satellites are expected to terminate their operational life around 2002/2003 and a decision is to be made on how to procure the communications capacity required to support NATO operations after that period. Based on the above consideration, we will examine a range of solutions to overcome the possible lack of

NATO MILSATCOM assets in the next few years.. In addition the possible solutions will be based on the criteria of using entire units and packages available off the shelf as many as possible for the construction of the NATO Gap Filler Satellite.
Derived from text
Artificial Satellites; Command and Control; Communication Satellites; Service Life

19970026424 Thomson-CSF, Ymare, France
EXPERIMENTAL ANTIJAMMING RESULTS OF AN ON-BOARD SATELLITE TELECOMMUNICATIONS ANTENNA *RESULTATS EXPERIMENTAUX D'ANTIBROUILLAGE D'UNE ANTENNE EMBARQUEE DE TELECOMMUNICATION PAR SATELLITE*
Tutard, P., Thomson-CSF, France; Poux, J. P., Thomson-CSF, France; Croq, F., Alcatel Espace, France; Jun. 1997; 10p; In French; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The next generation of military telecommunications satellites must make it possible to improve the effort to meet operational requirements by ensuring support primarily of simultaneous theaters of operations and powerful protection against electromagnetic jamming. An antijamming antenna demonstrator model, for SHF reception on board a satellite, was developed and built under the sponsorship of the General Delegation of Armament, Alcatel Espace, and THOMSON-CSF. This active multibeam antenna is combined with a self adaptive antijamming unit that employs a so-called 'secondary lobe opposition' technique. The analysis and simulation of several solutions led to the choice of an antenna with a reflector equipped with an active lens, combined with secondary lobe opposition treatment. The secondary lobe opposition eliminates jamming on the principal channels by means of the weighted addition - via the analog method - of the latter with the auxiliary channels intended to pick up the jammers. Adequate weighting is calculated numerically.
Derived from text
Telecommunication; Military Spacecraft; Multibeam Antennas

19970026425 Thomson-CSF, Bagneux, France
NUMERICAL TECHNOLOGIES FOR A SATELLITE TELECOMMUNICATIONS ANTIJAMMING PAYLOAD *TECHNOLOGIES NUMERIQUES POUR UNE CHARGE UTILE ANTI-BROUILLEE DE TELECOMMUNICATIONS PAR SATELLITES*
Armand, M., Thomson-CSF, France; Elleaume, P., Thomson-CSF, France; Muller, B., Thomson-CSF, France; Poux, J. P., Thomson-CSF, France; Primard, J. F., Thomson-CSF, France; Quignon, T., Alcatel Espace, France; Jun. 1997; 10p; In French; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Future generations of military satellite communications systems will require vast protection against jamming and a greater facility for interconnections between nations of different types. Meeting these needs calls for an antijamming computer to handle the transmission function. This computer performs different functions numerically: high-frequency numerical acquisition of sampling of data blocks coming from a transmission channel or channels; and intensive antijamming processing, requiring especially the formation of inter-correlation matrixes and the resolution of linear systems.
Derived from text
Satellite Communication; Satellite Transmission; Telecommunication; Communication Satellites

19970026429 Aerospace Corp., Los Angeles, CA United States
ELECTRO-OPTICAL SENSOR SIMULATION FOR THEATRE MISSILE WARNING
Lawrie, D. G., Aerospace Corp., USA; Kafesjian, S. L., Aerospace Corp., USA; Hamilton, J. N., Aerospace Corp., USA; Casey, E. J., Aerospace Corp., USA; Robinson, I. S., Aerospace Corp., USA; Jacobs, M. M., Aerospace Corp., USA; Jun. 1997; 18p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

An integrated Electro-Optical Sensor Simulation (EOSS) capability has been developed which can analyze the performance of space-based, surveillance systems at both the sensor and constellation levels. For sensors operating in an infrared-blocking band against an earth background, target detection is generally limited by sensor output variations known as clutter, which results from the interaction of the sensor with background scene structure such as clouds. EOSS uses a scene generation model to create the required cloud scenes and an end-to-end simulation of the imaging chain to evaluate the impact of these backgrounds on sensor performance. Results from these detailed simulations are combined within a constellation-level analysis tool to provide global sensor coverage and target detection statistics as a function of sensor design, background level, target parameters, and constellation size and type. This simulation capability has been used to determine theatre missile detection and report times for a representative spacebased, infrared surveillance architecture. The trade between sensor performance and payload weight has also been explored, with uncertainties in the background clutter modeling playing a key role in driving the sensor designs in the direction of heavier and more expensive payloads.
Derived from text
Missile Detection; Missiles; Target Acquisition; Surveillance; Infrared Radiation; Electro-Optics

19970026431 Aerospace Corp., Los Angeles, CA United States
APPLICATION-SPECIFIC BANDWIDTH COMPRESSION FOR DISSEMINATION OF IMAGE DATA
Danahy, S. B., Aerospace Corp., USA; Hou, H. S., Aerospace Corp., USA; Habibi, A., Aerospace Corp., USA; Bassett, E. M., III, Aerospace Corp., USA; Jun. 1997; 8p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Image data collected in support of NATO forces continues to increase in quantities which exceed the available communications links. to address the mismatch in data volumes and communications lines, bandwidth compression techniques are being developed and implemented. We refer to the systems, both the hardware and software, used for compression and decompression of image data as codecs compressor/decompressor systems. Codecs have traditionally been optimized for a number of different criteria, including: the speed of decompression, ability to recover from transmission errors, preservation of specific image attributes, maintenance of visual quality, and communication factors including target bit rates. This paper will examine a family of codec systems in terms of military support, and an analysis of selected codecs will be performed. The analysis is based on an expanded optimization criterion. The new codecs criterion includes the maintenance of image quality as related to machine processing for image understanding and information extraction. Consideration will also be given to the suitability of space implementation for the compression system.
Derived from text
Bandwidth; Communication Cables; Communication Networks; Computers; Data Transmission; Image Processing; Image Resolution

19970026435 MATRA Marconi Space, Surveillance Applications, Portsmouth, United Kingdom
STRAWMAN CONCEPT AND PANEL DISCUSSION
Hall, C. D., MATRA Marconi Space, UK; Jun. 1997; 4p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The Strawman Concept provided a focus for a discussion which was initiated by the symposium steering committee and then expanded to include discussion with members of the symposium as a whole. This paper presents an account of the proposition put to the symposium prior to the Discussion, of the issues raised for discussion, and the arguments and issues raised by the symposium members as a part of the panel discussion.
Derived from text
Space Communication; Space Flight; Space Commercialization

19970026663 Advisory Group for Aerospace Research and Development, Sensor and Propagation Panel, Neuilly-Sur-Seine, France
RADAR SIGNATURE ANALYSIS AND IMAGING OF MILITARY TARGETS *L'ANALYSE DE LA SIGNATURE RADAR ET DE LA VIDEOSCOPIE DE CIBLES MILITAIRES*
Apr. 1997; 196p; In English; In French, 7-10 Oct. 1996, Ankara, Turkey; See also 19970026664 through 19970026682
Report No.(s): AGARD-CP-583; ISBN 92-836-0039-8; Copyright Waived; Avail: CASI; A09, Hardcopy; A03, Microfiche

Radar has been around for more than half a century now. During this time it has reached both widespread application and a high degree of sophistication. Still, it is far from being a mature science. Major improvements in concept, componentry and information exaction continue to make radar more capable in detecting and identifying targets. Parallel with this development, the concealment of military

targets is an ever-increasing necessity and is progressing with similar strides. A review of recent developments in the analysis of radar signatures of military targets is therefore timely and appropriate. The symposium addressed many aspects of this multi-faceted topic. Numerical target modeling holds great attraction. Methods are presented to render the problem computationally more efficient. Simulation and scaled measurements in comparison with full-size target measurements serve to build confidence in using a cost-effective combination of these techniques to determine radar cross section data. Environmental factors such as rain depolarization and surface multi-path propagation were considered, along with man-made chaff as they impact on radar. An important subject for study was the robustness of non-cooperative target identification based on target doppler characteristics, polarimetry and one- or two-dimensional imaging. The availability of large amounts of data from modem radar systems makes the automation of target detection almost mandatory. The benefits of different approaches are compared. Signature modification is a prerequisite for target survival in the sophisticated electronic warfare arena of the future. Papers ranged from low radar cross section structural designs and retrofits to active cancellation techniques.
Author
Radar Imagery; Radar Tracking; Target Acquisition; Electronic Warfare; Cost Effectiveness; Radar Cross Sections; Radar Signatures; Signature Analysis; Radar Targets; Imaging Techniques

19970026664 Technical Univ. of Istanbul, Faculty of Aeronautics and Astronautics, Turkey
RCS EVALUATIONS WITH COMPUTATIONAL ELECTROMAGNETICS
Gulcat, U., Technical Univ. of Istanbul, Turkey; Usta, E., Technical Univ. of Istanbul, Turkey; Aslan, A. R., Technical Univ. of Istanbul, Turkey; Radar Signature Analysis and Imaging of Military Targets; Apr. 1997; 10p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Applications of a finite difference time domain method for the solution of the Maxwell's equations involving arbitrary shapes are presented. The method used is based on explicit Lax-Wendroff scheme applied to the transformed equations expressed in generalized coordinates. Only the scattered field variables are solved to evaluate the surface current and the bistatic radar cross section. The computer code developed is first calibrated with the analytical solutions and then the code is used to calculate the RCS for perfectly conducting arbitrary shapes immersed in transverse magnetic plane waves.
Author
Radar Cross Sections; Radar Signatures; Maxwell Equation; Finite Difference Theory; Computational Electromagnetics; Multistatic Radar

19970026665 Defence Research Agency, Malvern, United Kingdom
AN ADVANCED NUMERICAL SCHEME FOR COMPUTATIONAL ELECTROMAGNETICS
Gallagher, J. G., Defence Research Agency, UK; Hodgetts, T. E., Defence Research Agency, UK; Lytton, C. C., Defence Research Agency, UK; Arthur, M. T., Defence Research Agency, UK; King, I. D., Defence Research Agency, UK; Apr. 1997; 10p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Computational electromagnetics and computational fluid dynamics have evolved as independent areas of numerical analysis, but the equations which are solved in these two areas are fundamentally similar. It therefore seems plausible that methods developed in one area should also be applicable to the other, with possible savings of time and computer resources. This paper describes a test of this idea: a general method originally developed for aerodynamics calculations by specialists at the farnborough site of the Defence Research Agency (DRA) is now being adapted for electromagnetic calculations, with the collaboration of specialists at the DRA's Malvern site. The preliminary results are very encouraging.
Author
Computational Electromagnetics; Numerical Analysis; Aerodynamics

19970026666 Centre d'Electronique de l'Armement, Bruz, France
RADAR REFLECTIVITY OF A TARGET ILLUMINATED BY A SPHERICAL WAVE
Pouliguen, P., Centre d'Electronique de l'Armement, France; Gadenne, P., Centre d'Electronique de l'Armement, France; Marty, J. Y., Centre d'Electronique de l'Armement, France; Apr. 1997; 16p; In French; See also 19970026663; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This article describes a theoretical method for calculating the equivalent radar surface of a target illuminated by a plane or spherical electromagnetic wave. The method is based on the integral formula of Stratton Chu, simplified by the hypotheses of physical optics. Developed and set up in the form of the sermail calculations code by the Celar (Weapons Electronic Center), it is used particularly to check the quality of acquisitions at the great Solange Equivalent Radar Surface measurement base whose characteristics are reviewed. A comparison of the theoretical and experimental results obtained from some canonical target is also provided.
Author
Radar Targets; Radar Imagery; Spherical Waves; Reflectance; Plane Waves; Physical Optics; Illuminating

19970026667 Patras Univ., Dept. of Chemical Engineering, Greece
LOW FREQUENCY SCATTERING BY TARGETS ABOVE A GROUND PLANE
Dassios, George, Patras Univ., Greece; Kleinman, Ralph, Delaware Univ., USA; Apr. 1997; 10p; In English; See also 19970026663
Contract(s)/Grant(s): F49620-96-I-0039; AGARD-G-84; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Low frequency scattering by isolated targets in space has been well studied and there exists a general theory as well as explicit results in special target shapes. In the present paper we develop a comparable theory br low frequency scattering of targets above a flat plane. The presence of the ground plane has a considerable radar cross section of the scatterer and this effect is highly dependent on the boundary condition used to model the ground.
Derived from text
Radar Cross Sections; Boundary Conditions; Targets

19970026668 Rutherford Appleton Lab., Chilton, United Kingdom
RCS CALCULATIONS WITH THE PARABOLIC WAVE EQUATION
Levy, M. F., Rutherford Appleton Lab., UK; Borsboom, P.-P., Rutherford Appleton Lab., UK; Zaporozhets, A. A., Rutherford Appleton Lab., UK; Zebic-LeHyaric, A., Rutherford Appleton Lab., UK; Apr. 1997; 12p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Parabolic equation (PE) techniques have been used for some time to solve various types of wave propagation problems. They provide an efficient solution for long-range forward propagation radar and sonar predictions. More recently, they have been applied to scattering problems, and in particular to RCS calculations. Our aim in this paper is to summarize the PE techniques currently available for RCS work and to give a kw typical examples in two and three dimensions.
Author
Wave Propagation; Scattering

19970026669 Bilkent Univ., Dept. of Electrical and Electronics Engineering, Ankara, Turkey
FAST RADAR CROSS SECTION (RCS) COMPUTATION VIA THE FAST MULTIPLE METHOD
Gurel, Levent, Bilkent Univ., Turkey; Apr. 1997; 14p; In English; See also 19970026663
Contract(s)/Grant(s): EEEAG-163; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The fast multipole method (FMM) is used for the fast radar cross section (RCS) computation of large canonical two-dimensional geometries in both homogeneous and layered media Numerical solution of electromagnetic scattering problems are invaluable in many real-life applications. However, real-life problems translated into very large

numerical problems and when accurate solutions are desired, the size of the problem that can be solved using traditional techniques is limited by the given computational resources.
Derived from text
Radar Cross Sections; Electromagnetic Scattering; Moving Target Indicators

19970026670 Universidad de Vigo, Dept. Tecnologias de las Comunicaciones, Vigo, Spain
STATISTICAL ANALYSIS OF PROPAGATION PARAMETERS FOR POLARIMETRIC RADAR MEASUREMENTS
Antar, Y. M. M., Royal Military Coll. of Canada, Canada; Santalla-delRio, V., Universidad de Vigo, Spain; Apr. 1997; 10p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Analysis of the polarimetric scattering matrix or the covariance matrix has become an important tool in remote sensing applications. Propagation to and back from the target is affected by the medium. Rain media usually present some anisotropy that causes depolarization of the wave and can greatly affect either the scattering matrix or the covariance matrix obtained. Depolarization effects through propagation should then be corrected for. These effects can be determined and accounted for if the characteristic polarizations of the medium (those that propagate without changing their polarizations) and their respective propagation constants are known. In examining the backscattering properties of rain media it is found that they present reflection symmetry. This is an important property that leads to linear and orthogonal characteristic polarizations. Measurement of the covariance matrix in the polarization base defined by the characteristic polarizations allows extraction of propagation parameters from the copolar power and copolar correlation terms. Different algorithms can be designed for its extraction. In order to be able to compare them, statistical analysis of polarization covariance matrix is performed. This analysis considers also the correlation effects between successive data samples.
Author
Statistical Analysis; S Matrix Theory; Remote Sensing; Depolarization; Backscattering

19970026671 Roke Manor Research Ltd., Romsey, United Kingdom
EXTENDED TARGET SIMULATION AT A PHYSICAL LEVEL
Simpson, S. H. W., Roke Manor Research Ltd., UK; Galloway, P. E. R., Roke Manor Research Ltd., UK; Apr. 1997; 6p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The paper describes an approach to the simulation of radar signatures from large complex targets. The issue addressed is that given a subject radar target in the form of a geometrical design, is it possible to recognize redundancy in the electromagnetic radiation source which this target represents when illuminated by radar? This is a key issue since the task of directly evaluating the signature is often so compute intensive as to prohibit its use in a simulator.
Author (revised)
Electromagnetic Radiation; Radar Signatures; Radar Targets

19970026672 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Physics and Electronics Lab., The Hague, Netherlands
LIVORNO 1996: THE CENTIMETRE AND MILLIMETRE WAVE RADAR SIGNATURE AND PROPAGATION TRIAL BY NATO AC/243 (PANEL 3/RSG.21)
Heemskerk, H. J. M., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Apr. 1997; 8p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The RCS measurements have been made at frequencies from 3 to 94 GHz by high resolution radar all member nations. The targets were an auxiliary ship and a frigate. In order to investigate the environmental effects radar measurements have been made on a corner reflector, refractivity profiles and sea states have been measured during the trial.
Derived from text
Wave Propagation; Radar Signatures; Radar Corner Reflectors; High Resolution; Millimeter Waves

19970026673 Ecole Royale Militaire, Chaire de Telecommunications, Brussels, Belgium
PULSE RESPONSE OF THREE-DIMENSIONAL MILITARY TARGETS CONCEPTION, DEVELOPMENT AND CHECK OF A MEASUREMENT BENCH ***RESPONSE IMPULSIONNELLE DE CIBLES MILITAIRES TRIDIMENSIONNELLES CONCEPTION, DEVELOPPEMENT ET VALIDATION D'UN BANC DE MESURE***
Piette, Marc, Ecole Royale Militaire, Belgium; Apr. 1997; 14p; In French; See also 19970026663; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

After a review of the general problem inherent in the identification of non-cooperative radar targets and a brief look at the most promising identification techniques, this report describes the measurement bench that was designed and developed in the laboratories of the Royal Military Academy to measure the pulse response of three-dimensional targets. The originality of this bench essentially resides on the fact that measurement is done directly in the real-time frame and that there is no need for any anechoic chamber, as in the conventional frequency method to which it is compared. Checked out by means of canonical targets, the bench is now used for the experimental determination of the pulse response of any three-dimensional targets.
Author
Radar Targets; Anechoic Chambers; Pulse Radar

19970026674 Cologne Univ., Physikalisches Inst., Germany
NOVEL HF, RADAR AND IR ABSORBER MATERIAL
Nimtz, Guenter, Cologne Univ., Germany; Apr. 1997; 6p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A novel broadband absorber is introduced. Instead of the classical voluminous carbon loaded foam, the new absorbing element is a thin metal layer of only some 10 nm thickness. Measurements of the electromagnetic specifications of anechoic chambers built with absorbers made of the new material have revealed a better field homogeneity than known from those built with the classical foam absorbers. Other properties are the light weight of the absorbers and they can be made from non-combustible material. The absorbing and low reflecting properties of the mesoscopic metal layers are effective up to infrared frequencies. There will be introduced some applications of the novel technology.
Author
Radar Absorbers; Anechoic Chambers; Broadband; Absorbers (Materials)

19970026675 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Radio Frequency Technology, Wessling, Germany
EXPERIMENTAL EVALUATION OF MATERIAL PARAMETERS FOR RCS PREDICTION CODES
Preissner, J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Stein, V., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1997; 10p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The material parameters, permittivity epsilon and permeability Mu, which are needed for the calculation of the mono- and bistatic radar cross section of complex structures, have been determined for a lot of samples in the frequency range from 8 GHz to 110 GHz. Three different methods, the measurement of the S-parameters in a waveguide, the measurement of the reflection or transmission factor under free space conditions, measurements of the reflection factor by a coaxial probe, have been applied and are described in detail. The quality of the results is dependent on the method chosen, as well as on the accuracy in the fabrication of the samples, which is in general more critical at higher frequencies. Some measurement results are presented and discussed in detail.
Author
Radar Cross Sections; Waveguides; Multistatic Radar; Microwave Frequencies

19970026676 Rome Lab., Hanscom AFB, MA United States
CAPTIVE-TARGET IMAGING AT SUB-MM THROUGH CM WAVELENGTHS
Marr, Richard A., Rome Lab., USA; Lammers, Uve H. W., Rome Lab., USA; Apr. 1997; 8p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

We developed instrumentation radars in the sub-mm and mm wavelength range for two dimensional (2-D) imaging. Salient features

of these systems are mechanical frequency shifting for a very high degree of phase stabilization and target precessional motion for cross-range/ cross-range imaging. We designed a cm wavelength radar which additionally uses a wideband waveform for ranging to permit three dimensional (3-D) imaging. The latter system is fully polarimetric. All radars use a form of moving target indicator (MTI) cancellation to suppress background clutter. The operation of these systems and examples of data measured on canonical bodies and model targets are discussed.
Author
Waveforms; Rangefinding; Polarimetry; Moving Target Indicators

19970026677 Massachusetts Univ., Dept. of Electrical Engineering, Lowell, MA United States
IMAGING 3D STRUCTURES FROM LIMITED-ANGLE BACKSCATTERED DATA
Pommet, D. A., Massachusetts Univ., USA; Fiddy, M. A., Massachusetts Univ., USA; Marr, R. A., Rome Lab., USA; Lammers, U. H. W., Massachusetts Univ., USA; Morris, J. B., Rome Lab., USA; Apr. 1997; 10p; In English; See also 19970026663
Contract(s)/Grant(s): N00014-89-J-1158; F19628-95-C-0035; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche
We consider the problem of imaging strongly scattering, penetrable targets by inverting scattered field data. We describe a method to recover images of strongly scattering targets based on a modification of the well-known technique of diffraction tomography. It is a nonlinear (differential cepstral) filtering process. In order to overcome the problems associated with limited angular measurements of the scattered field, as described by Lammers and Marr in the preceding paper, we have to incorporate Fourier-based methods for spectral estimation. The advantages and difficulties associated with this new method are described.
Author
Imaging Techniques; Backscattering; Cepstral Analysis

19970026678 Royal Military Academy, Armament and Ballistics Dept., Brussels, Belgium
AUTOMATIC RECONNAISSANCE OF TARGETS DETECTED BY THE SCB2130A SURVEILLANCE RADAR *RECONNAISSANCE AUTOMATIQUE DES CIBLES DETECTEES PAR LE RADAR DE SURVEILLANCE SCB2130A*
Pirlot, M. C., Royal Military Academy, Belgium; Apr. 1997; 8p; In French; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche
The radar, as a matter of fact, makes it possible to detect moving targets. The operators of the 2nd Light Cavalry can use their equipment to spot and locate miscellaneous vehicles (tanks, armored troop carriers, wheeled vehicles, etc.) but also much smaller targets, such as just one man.
Derived from text
Surveillance Radar; Reconnaissance

19970026679 Netas Northern Electric Communications, Inc., System Planning Dept., Istanbul, Turkey
MODELING OF ISAR IMAGERY FOR SHIPS
Emir, K., Netas Northern Electric Communications, Inc., Turkey; Topuz, E., Technical Univ. of Istanbul, Turkey; Apr. 1997; 6p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche
An alternative approach is proposed for the modeling of ISAR imagery for ships, which can effectively be used to generate images in sufficient accuracy as to correctly represent the dominant scattering phenomena. This approach relies on doing some preprocessing on the data for each particular problem, so as to simplify the modeling of the ships surface. Our preliminary numerical results demonstrate that the proposed technique is computationally very efficient. Moreover, the generated data is sufficiently accurate and can be fed into the recently developed automatic classification algorithms which are based on localization of dominant scattering centers on the target.
Author
Classifications; Imagery; Preprocessing

19970026680 Roke Manor Research Ltd., Romsey, United Kingdom
AN APPROACH TO PHYSICAL LEVEL CHAFF SIMULATION
Simpson, S. H. W., Roke Manor Research Ltd., UK; Galloway, P. E. R., Roke Manor Research Ltd., UK; Radar Signature Analysis and Imaging of Military Targets; Apr. 1997; 4p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche
This paper describes the construction and calibration of a signal generator for representing the distributed phasor vector radar signature of a chaff round. The fundamental approach together with some alternative methods of calibration are discussed, and some results are presented. The paper is written assuming that the reader is familiar with chaff, its terminology and its methods of deployment. The body of the paper concentrates on producing a model of chaff that is sufficiently accurate and adaptable to represent a given chaff round at a physical level. In particular, the possibility of using physical level Computer Aided Engineering (CAE) to calibrate the model is addressed.
Author
Signal Generators; Radar Signatures; Calibrating

19970026681 Thomson-CSF, AIRSYS, Bagneux, France
ANALYSIS OF EXPERIMENTAL DATA FOR NCTR TARGET MODELLING
Moruzzis, Michel, Thomson-CSF, France; Guillerot, Jean-Claude, Thomson-CSF, France; Lestrade, Christian, Thomson-CSF, France; Apr. 1997; 8p; In English; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche
In this paper one presents some experimental results obtained for different radar bands and different NCTR techniques. These results are then analysed in terms of robustness and one draws some trends regarding the kind of features which can be used for NCTR. Finally one suggests a method for designing NCTR systems based on both target and measurement conditions modeling.
Author (revised)
Robustness (Mathematics); Robotics; Robot Dynamics

19970026682 Thomson-CSF, Applications Radar, Velizy, France
HIGH RESOLUTION BENCH (HRB) FOR THE ANALYSIS OF SHIP SIGNATURES *BANC A HAUTE RESOLUTION (BHR) POUR L'ANALYSE DE CIBLES MARINES*
Delhote, Christian, Thomson-CSF, France; Perret, Frederic, Thomson-CSF, France; Isnard, Jean, Thomson-CSF, France; Apr. 1997; 10p; In French; See also 19970026663; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche
The control of the radar signature for surface vessels is a key factor to their survivability. After a short reminder about the motivations for the knowledge and control of this signature, three main analysis methods are presented along with their advantages and drawbacks. Next, the HRB (High Resolution Bench) is described in detail as a large bandwidth polarimetric measurement equipment, developed hy THOMSON-CSF Applications Radar, operated by the French Navy technical services, and which enables a refined analysis of the vessels signature, even in an environment comprising self-screening electromagnetic decoys. After a description of the measurement instrument and its operating modes, the characteristics of the measurements which the HRB can provide are presented as well as the refined analysis software for these signatures. Next the technical characteristics tor the main components of the radar are detailed. Finally, the calibration problem posed by this type of large bandwidth polarimetric measurement equipment is briefly discussed.
Author
Signature Analysis; Ships; Radar Signatures; High Resolution; Bandwidth

19970029357 Second Air Supply and Maintenance Center Command, Kayseri, Turkey
EXPERIMENTAL ANALYSIS OF EFFECTS OF ANOMALIES IN STRUCTURE OF RADOMES ON RADOME'S PERFORMANCE
Celikel, Sadik, Second Air Supply and Maintenance Center Command, Turkey; Gorur, Adnan, Nigde Univ., Turkey; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche
In this study, radome structures, located in the nose section of aircrafts, which protect radar antennas from adverse environmental effects, fit to aircraft structures aerodynamically but which differ from other parts of aircrafts in terms of electrical features have been examined basically. Effects of radome structural anomalies to radome electrical performance have been investigated by bonding mica plates

at some parts of electromagnetic window section of an F-4 nose radome which differ the thickness of the structure. Transmission loss, boresight error, boresight error measurements, have been achieved via B-350A Test Utility System. Consequently, experimental analysis of anomalies which occur as variation at density and thickness of radome structures have been evaluated.
Author
F-4 Aircraft; Radomes; Radar Antennas; Electrical Properties; Aircraft Structures

19970029362 Ministry of Defence, Bonn, Germany
MULTIFUNCTIONAL RADIO SYSTEMS FOR MULTINATIONAL FORCES
Mey, G., Ministry of Defence, Germany; Reitberger, P. H., Rohde and Schwartz, Germany; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Modern technological and technical possibilities of multifunctional, fault-tolerant radio systems for armed forces operations are described. With the availability of new technologies it appears technically feasible to adjust the nationally diverse radio signal formats in multinational operations and to exchange them internationally without compromising any security interests of the operating forces. The central technical parameters of the participating nations' radio functions need to be exchanged for this purpose. However, such parameter exchange does not restrict the use of nationally defined waveforms. Due to present capabilities, the simultaneous use of radio functions on a national and multinational basis is possible for cooperating forces and, due to the expected benefits, ought to be recommended . Command distribution via both national communication channels and multinational fast communication channels permits nationally supported multinational command structures. A unique way to achieve different national COMSEC codes will be derived from so-called c*) Codes. The c code can be transmitted via national and multinational protected channels without any loss of security. Armed forces require a new, additional possibility of operating with multifunctional radio systems in missions with high security requirements for the communication equipments. During mission preparation, the ECCM measures for the communication systems are designed especially for the mission. Such radio waveforms tailored for a specific mission will result in greater protection compared with generally defined radio waveforms, which are partially known worldwide, without losing the possibility of cooperating with other participating forces, by using exchangeable waveforms for these communication links.
Author
Telecommunication; Waveforms; Radio Signals; Fault Tolerance; Communication Networks; Communication Equipment

19980016575 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Hochfrequenztechnik, Oberpfaffenhofen, Germany
AIRBORNE AND SPACEBORNE SAR SYSTEMS: POSSIBILITIES AND LIMITATIONS FOR MILITARY USE
Keydel, Wolfgang, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 10p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Synthetic Aperture Radar (SAR) is perfectly suited for aerospace surveillance and reconnaissance systems. In principal, SAR combines the advantages of microwave systems like weather independence, optical visibility, penetration capability. The state of the art as well as the development of technique and technologies needed and possibilities of future systems will be shown briefly.
Author
Synthetic Aperture Radar; Space Surveillance (Spaceborne); Aerial Reconnaissance; Radar Detection; Radar Equipment

19980016576 Royal Military Academy, Dept. of Electricity/Telecommunications, Brussels, Belgium
ULTRA-WIDE-BAND TECHNIQUES AND THEIR PRACTICAL USES ***TECHNIQUES A BANDE ULTRA-LARGE ET APPLICATIONS***
Piette, Marc, Royal Military Academy, Belgium; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 14p; Summary translated by Schreiber; In French; See also 19980016571; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The purpose of this communication is to present an introduction to ultra-wide-band radars and their technology. After defining the terminology inherent in these new radars and describing it specifically, we describe the form of the signals they emit by comparing them -- in terms of time and frequency -- to the signals that are emitted by the conventional radars. We then move on to a review of the various types of transmitters that can be used, the specific antennas that were developed recently, and the possible structures of the receiver. Finally, we briefly present the techniques of analysis and processing of signals that are specifically related to nonsinusoidal and pulse signals, before stating some conclusions as to future prospects.
Transl. by Schreiber
Broadband; Signal Analysis; Telecommunication; Signal Processing; Radar Equipment

19980016577 Otto-von-Guericke Univ., Magdeburg, Germany
HIGH-POWER MICROWAVES EFFECTS ON SMART ELECTRONIC WEAPON SYSTEMS
Nitsch, J., Otto-von-Guericke Univ., Germany; Bohl, J., Diehl G.m.b.H. und Co., Germany; Straehle, U., Ministry of Defence, Germany; Kaiser, A., German Armed Forces Scientific Inst. for Protection Technologies, Germany; Meyer, L., German Armed Forces Scientific Inst. for Protection Technologies, Germany; Vogel, H. J., German Armed Forces Scientific Inst. for Protection Technologies, Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 14p; In English; See also 19980016571; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

In this paper we describe the coupling of microwaves to smart electronic weapon systems. Analytical and numerical calculations of an almost real model of a weapon system give a first idea concerning the results of a strong interaction of an electromagnetic wave with the system under consideration. Subsequent experiments with the passive system confirm the expected results and/or add new, sometimes unexpected ones to the former. They together form the basis for the final tests with the active smart system. Whereas the passive tests mainly are performed with low power excitation in the cw-modus, experiments with the active system are conducted with quite different power levels and the variation of many other HPM-parameters. The magnitudes of the perturbation quantities inside the system are measured and stored and serve as input data for a flightpath simulation program. With the aid of such a program one can make a prediction whether or not the smart weapon system can fulfill its mission. It is shown that interferences lasting longer than about 1.5 s lead to mission interruption. Hardening and defense aspects are discussed at the end of the paper.
Author
Weapon Systems; Electronic Warfare; Mathematical Models; Microwaves; Simulation; Military Technology

19980016578 Thomson-CSF, Radars and Contre-Mesures, Elancourt, France
TRENDS IN AIRBORNE ELECTRONIC WARFARE: A EUROPEAN PERSPECTIVE
Baratault, P., Thomson-CSF, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 8p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Electronic warfare is one of the areas in which each major nation has tried to stay largely independent. As the European construction programme continues and budgets shrink, it would be reasonable to assume that this situation is now going to change quite quickly. In any case, the industry must be prepared for this scenario, even if the decisions are basically political. The first point examined in this paper is that electronic warfare should be considered as a whole. It should no longer be approached on a programme-by-programme basis, or just in terms of equipment. On the contrary, our vision of electronic warfare should encompass intelligence gathering (to define the threats), technico-operational simulation (to specify which systems and equipment are needed to deal with the threats), evaluation, tests, and life cycle support. and our approach to electronic warfare should also include all the spectral components of known or predictable threats. A second consideration is that electronic warfare can no longer be dealt with as a separate area of interest. This is partly because of cost constraints, but partly because of the specific technical problems involved in co-siting different systems on board on an aircraft. It is becoming more

and more vital to make different systems share technical functions, apertures and time slots. Current developments in modular integrated avionics are moving in this direction. Further efforts are needed in the field of sensors and antennas. The third consideration discussed here is primarily of concern to our industry, but it cannot leave governments indifferent, as what is at stake is Europe's independence. I am talking here of the vital importance of maintaining European capacity in key technologies for which commercial applications cannot yet generate sufficient volume or which have cycle times that are incompatible with military programmes.
Author
Electronic Warfare; Military Technology; Weapon Systems; Costs

19980016579 Royal Military Academy, Signal and Image Centre, Brussels, Belgium
FUTURE TRENDS IN IMAGE PROCESSING AND PATTERN RECOGNITION
Acheroy, Marc, Royal Military Academy, Belgium; Korn, Axel, Fraunhofer-Inst. fuer Informations- und Datenverarbeitung, Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 10p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The strong evolution of the scientific background and of the imaging technology is transforming image processing in a discipline where the boundaries between the sensor system, the processing system and the visualization and/or decision making system are vanishing. Indeed, it is more and more difficult to split the design of signal processing algorithms from the design of pattern recognition algorithms or the preprocessing dedicated to the sensor system from the decision making process. Sensor systems are also evolving very fast, their variety increases and their resolution is getting better in all domains (temporal, spatial and wavelength domains). Therefore, they are one of the fundamental reasons for the modern evolution in processing algorithms and hardware design, especially in data fusion and parallel processing. The design of modern pattern recognition systems, that show an intelligent behaviour, has to cope with the huge multiplicity of inputs at different levels. These inputs must be combined and fused in order to extract the useful information and to make possible the decision making. Finally, the computer hardware performance and integration fortunately still increase exponentially so that it still remains possible to implement the more and more sophisticated, real-time or near real-time applications on existing hardware.
Author
Signal Processing; Image Processing; Pattern Recognition; Real Time Operation; Algorithms; Multisensor Fusion

19980016580 Defence Evaluation Research Agency, Radio Science and Propagation Group, Malvern, United Kingdom
REAL TIME SPECIFICATION OF THE BATTLE SPACE ENVIRONMENT AND ITS EFFECTS ON RF MILITARY SYSTEMS
Cannon, Paul S., Defence Evaluation Research Agency, UK; Richter, Juergen H., Naval Air Warfare Center, USA; Kossey, Paul A., Phillips Lab., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 12p; In English; See also 19980016571; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The critical nature of electromagnetic propagation assessment in the development of a wide range of sensor, communications, and weapon systems is highlighted. A brief description of the Battle Space Environment, together with methods to specify it are given. A number of contemporary decision aids are used to illustrate both the importance of accurate, timely environmental specification, and of accurate ray-tracing, to NATO operations. The importance of using new sensors, data fusion and advanced computer assets is identified.
Author
Electromagnetic Wave Transmission; Real Time Operation; Telecommunication; Radio Frequencies; Atmospheric Effects; Weapon Systems; Wave Propagation; Radio Transmission; Military Operations

19980016581 National Defense Univ., Information Warfare Service, Washington, DC United States
FROM INFORMATION WARFARE TO INFORMATION POWER: A NEW PARADIGM FOR NATIONAL SECURITY IN THE INFORMATION AGE
Kuehl, Dan, National Defense Univ., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 10p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The passage of the Goldwater-Nichols Act in 1986 generated a new emphasis on "jointness" in the American military. Current concepts of jointness and joint operations are encapsulated in the existing definition found in Joint Publication 1-02, which defines joint as "activities, operations, organizations, etc., in which elements of more than one Service of the same nation participate." The question at hand, however, is whether this concept, centered on blending the operations and capabilities of the four military Services, is sufficient for information warfare (IW) and the needs of national security in the information age. Are the impacts and implications of the information revolution so widespread that they necessitate a new perspective on who should be covered by the umbrella of jointness? The thesis of this paper is that the current Service-focused understanding of jointness is insufficient because it is too narrow, and that a broader and more inclusive concept that incorporates all of the various elements of national information power is necessary.
Author
Armed Forces (USA); Information Systems; Defense Program; Warfare

19980016587 GEC-Marconi Research Centre, Communications and Computing Lab., Chelmsford, United Kingdom
MODELLING AND SIMULATION OF COMMUNICATION SYSTEMS
Alston, I. D., GEC-Marconi Research Centre, UK; Currie, J. C., GEC-Marconi Research Centre, UK; Dearlove, C. M., GEC-Marconi Research Centre, UK; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 12p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The design of digital communication systems involves the definition of the system architecture (e.g. network topology, protocols); the design and modelling of the algorithms/behaviour of the system (e.g. signal processing functions); the design of the hardware/software architecture to be employed; and finally, implementation of the algorithms on the chosen architecture. During this design lifecycle the performance of the communications system can be evaluated in three ways, the paper will briefly discuss the characteristics of these methods and highlight when computer modelling/simulation is the best and most efficient way forward in order to gain an understanding of a communication system and an estimate of its performance. The paper will discuss the migration from computer modelling using standard high-level languages such as FORTRAN towards the use of high level design and simulation packages. The paper will show how such a commercially available package was used to model the physical layer of a public air-to-ground telephone system. The paper will also show how the modelling activity was used within the standardization process and how these new tools allow models to evolve easily introducing more and more detail until it represents a very accurate model of the real system. The paper will also show how subsequently the computer model was used to assist in the implementation and testing phase of the project. Finally the paper will discuss the concept of rapid prototyping and its advantages and show how such a modelling tool can also be used to produce prototype equipment.
Author
Pulse Communication; Computerized Simulation; Computer Programs; Algorithms; Communication Networks; Signal Processing; Programming Languages

19980210657 Forschungsinstitut fuer Hochfrequenzphysik, Werthoven, Germany
TWO-FREQUENCY MILLIMETER WAVE SAR
Schimpf, H., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Essen, H., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Apr. 1998; 9p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

(NU) The FGAN-FHP MEMPHIS radar transmits simultaneously at 35 GHz and 94 GHz. Accordingly, when flown in a side-looking configuration, closely related SAR images can be generated for both frequencies. These two images can be combined for the purpose of target detection and discrimination. (NU) It is analyzed how this combination can be performed, and how one gains with respect to speckle reduction, target-to-background contrast, detection probability and false alarm rate. For this purpose, a subsequent feature

based prescreener and a subsequent feature based discrimination stage. (NU) For multi-look images that are mapped to the ground it is found that the combination of two different frequencies with like polarization provides better speckle reduction and target-to-background enhancement than the combination of two orthogonal polarization channels at the same frequency. The detection/discrimination results depend on how precisely the two images are registered.
Author
Synthetic Aperture Radar; Target Acquisition; Radar Imagery; Millimeter Waves

19980210658 Ministry of Defence, Paris, France
RADAR AND OPTRONIC MULTIPLE SENSOR SYSTEM FOR GROUND ATTACK *SYSTEME MULTI-SENSEURS RADAR ET OPTRONIQUE POUR L'ATTAQUE AU SOL*
Mignot, E., Ministry of Defence, France; Mestre, J. P., Thomson-CSF Optronique, France; Levaillant, D., Thomson-CSF Optronique, France; Apr. 1998; 9p; In French; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The variety of recent conflicts in which allied forces participated has demonstrated the limitations of air-to-ground existing armament systems (strong constraints on use, armaments that are too specific, insufficient firing ranges with respect to ground-to-air defences, etc.). France, for this reason, has set the goal of developing a new kind of tactical armament, which would be complementary to SCALP type cruise missiles. This modular design weapon system, designated AASM (modular air-to-ground weapon), will have ranges greater than 15 km and should be capable of two categories of metric and decametric precision. Before firing the weapons, it is necessary to carry out certain number of operations such as detection, recognition and location determination of the targets to be processed.
Author
Weapon Systems; Radar Detection; Missile Defense; Missile Ranges

19980210661 North Atlantic Treaty Organization, Command, Control and Sensor Div., s'Gravenshage, Netherlands
METHOD OF EVALUATING PERFORMANCE LEVEL OF A MULTIPLE-SENSOR TRACKING DEVICE *METHODE D'EVALUATION DES PERFORMANCES D'UNE POURSUITE MULTICAPTEUR*
Desbois, M., North Atlantic Treaty Organization, Netherlands; Apr. 1998; 9p; In French; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The purpose of this presentation is to describe the methodology which has been developed for evaluation of multiple-sensor tracking within the C3 agency of NATO. This methodology originally was developed for the purpose of quantifying the performance requirements in terms that are applicable to establishment of the recognized air picture (RAP) within the framework of drafting specifications for the future command and control system of air operations (air command and control system, ACCS) of NATO. A certain number of performance measurements (MOPs) have thereby been defined. A process of segmentation of the paths and trajectories of the followed targets is necessary as a prior condition to calculating one part of these measurements: description of this segmentation is also included in the developed methodology, just as the involvement of different filters which allow a targeted study of monitoring performance.
Author
Multisensor Applications; Command and Control; Remote Sensing; Remote Sensors; Image Analysis

19980210665 National Aerospace Lab., Emmeloord, Netherlands
ARTAS: MULTISENSOR TRACKING IN AN ATC ENVIRONMENT
Hogendoom, R. A., National Aerospace Lab., Netherlands; Neven, W. H. L., National Aerospace Lab., Netherlands; Apr. 1998; 8p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

ARTAS (an acronym for ATC Radar Tracker and Server) is currently in pre-operational test at four different sites in France, Germany and the Netherlands. The ARTAS system consists d a tracker, responsible for maintaining up-to-date target state vectors, and a server, which handles client subscriptions (e.g. from the ATC display system) and delivers the target state vectors to these clients. An ARTAS system co-operates with adjacent ARTAS systems by exchanging target state vector information. The main features of the ARTAS Tracker are; tracking with up to thirty radars (PR, SSR or CMB); on-line estimation of the radar systematic errors; online estimation of the radar accuracy and coverage; high-accuracy position and velocity-vector estimation; responsiveness to target maneuvers; insensitivity to clutter; and target classification. The tracking filters are interacting multiple-model (IMM)-based filters, a four-model filter for highs speed and highly maneuvering target and a two-model filter for low-speed targets. The plot-to- track association is based on probabilistic data association (PDA), with special joint probabilistic data association (JPDA) algorithms in case of target close approach situations. Track initiation is done by time-reversed multiple-hypothesis tracking. Target classification is based on Shafer-Dempster reasoning.
Author
On-Line Systems; Air Traffic Control; Display Devices

19980210666 Technical Univ. of Crete, Telecommunications Systems Inst., Athens, Greece
LOW ALTITUDE WAVE PROPAGATION EFFECTS IN A TRANSMITTER INDEPENDENT RECEIVER NETWORK
Farsaris, Nikos J., Technical Univ. of Crete, Greece; Stavroulakis, Peter P., Technical Univ. of Crete, Greece; Apr. 1998; 5p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

For the design and implementation of a Passive Multistatic Early Warning and/or Fire Control Radar (T.I.R.N., Transmitter Independent Receiver Network) many aspects include the environmental conditions that T.I.R.N's may encounter at operational conditions. Even operating in a standard troposphere, the result of the refraction phenomenon is the curved propagation of the electromagnetic waves. The problem becomes more complicated at low altitudes, where tropospheric refractive index variability, multipath propagation and clutter (sea or ground) must be taken into consideration in order to avoid erroneous results for the location of a target as well as its velocity estimation. Although simplified models of the above environmental parameters are used in this analysis, (e.g. lateral refraction variability is not studied here, and Weibull Distributions Model is taken for granted as regards the sea clutter), useful results can be produced for the evaluation of multistatic systems. In this paper a four-receiver model using the signal of a non-cooperative transmitter is evaluated for its sensitivity at the above conditions and is compared with a conventional monostatic radar operating with the same signal. It is shown that the T.I.R.N. proposed is a more efficient system than its monostatic equivalent. The results presented, despite of being strictly theoretical (not yet evaluated in real operational conditions) may help the design of multistatic radars.
Author
Wave Propagation; Electromagnetic Radiation; Transmitter Receivers; Multipath Transmission

19980210668 Laboratoire d'Etude des Transmissions Ionospheriques, Orsay, France
DATA MERGING AND RELIABILITY OF HIGH FREQUENCY TRANSMISSIONS *FUSION DE DONNEES ET FIABILITE DES TRANSMISSIONS HF*
Goutelard, C., Laboratoire d'Etude des Transmissions Ionospheriques, France; Caratori, J., Laboratoire d'Etude des Transmissions Ionospheriques, France; Pautot, C., Laboratoire d'Etude des Transmissions Ionospheriques, France; Apr. 1998; 6p; In French; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

High frequency reliable radio communications in decametric band is currently based on procedure such as ALE (Automatic Link Establishment), RTCE (Real Time Channel Evaluation) ... which purpose is to test channel transmission capacity and interferences level. Establishment tests, made in real time, give interesting results by using long time experienced procedures with very good instantaneous reliabilities. Though, procedure can be improved with short time prevision of transmission channel characteristics and with interferences forecasting which are numerous in decametric band. Ionospheric forecasting methods allow to take into account ionospheric transmission characteristic. It is supposed that a very short time forecasting method (1 to 2 hours) or that a short time method (24 to 48 hours) is implemented. Interference forecasting is of prime importance in prevision of good establishment of links. Electromagnetic spectrum observation in HF band shows that: u Correlation from a day to another of interferences levels are often strong; Spectral correlations are good until distance of about 400/500 km ; Interferences levels are depen-

dent of observation azimuth; and Spectral occupancy is correlated with critical frequency FoF2. Taking into account these characteristics lead to consider the establishment of interferences level forecasting and the critical frequency of F2 layer. Jamming level characterization is introduced by considering the notion of clear frequency for a specified level. Frequency is supposed to be clear for a threshold S if the interferences level remains lower to this threshold. Clearness probability can be determined for each traffic band and we can plot surface of probability that a clear frequency one day remains clear the following days. These surfaces plotted as a function of the threshold and the forecast horizon are shown. Correlation between spectral occupancy and FoF2 frequency is also modelised. Comparison between FoF2 frequency determined by zenithal sounding with measurement of occupancy - mIF -has be proved very satisfying. A data fusion processing lead to a totally passive method of real time network management.
Author
Radio Communication; Multisensor Fusion; High Frequencies; Decametric Waves; Critical Frequencies; Channel Capacity

19980210669 Laboratoire d'Etude des Transmissions Ionospheriques, Orsay, France
COLLATION OF DATA AND EXTREMELY LOW-POWER FINDER FOR TELECOMMUNICATIONS *FUSION DE DONNEES ET SONDEUR A EXTREMEMENT FAIBLE PUISSANCE POUR TELECOMMUNICATIONS*
Goutelard, C., Laboratoire d'Etude des Transmissions Ionospheriques, France; Pautot, C., Laboratoire d'Etude des Transmissions Ionospheriques, France; Apr. 1998; 6p; In French; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Radio communications in decametric band are made difficult by important variability of transmission channel and by level and density of interferences which congest this part of the radioelectric spectrum. Link establishment methods are currently based on a preliminary sounding of the channels and a scrutation of interference spectrum. This method is implemented by systems which works alternately with radio communication systems or use independent test system. The disadvantages of these methods lie in an uneasy uses and a often insufficient periodic actualisation of estimation. Implementation of system allowing to test channel with extremely low emitted power gives a new way very interesting to establish links and to keep them. Electromagnetic soundings of the ionosphere is limited by the problem of electromagnetic pollution they create, which limits their use, and by the high sensitivity of the interference included in the band. The emitted power reduction solves the first point, on condition that sensitivity to the jammers remains acceptable. This results is obtained for implementation of non linear signal processing which allows to choose the wave shape and coding by solving an optimisation problem without constraints. Results obtained allows to do soundings with very low power. We can notice the protection given by the new method. These news capacities allow a permanent ionospheric sounding, on all the frequencies. A data fusion can then be made taking into account available informations, especially ionospheric disturbances. This method can be applied in particular to the network management to improve their efficiency.
Author
Telecommunication; Decametric Waves; Ionospheric Disturbances; Ionospheric Sounding; Signal Processing

19980210670 Leeds Univ., Inst. of Integrated Information Systems, United Kingdom
HF TRANSMITTER LOCATION USING SUPER-RESOLUTION DF AND IONOSPHERIC SOUNDING
Strangeways, Hal J., Leeds Univ., UK; Apr. 1998; 9p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A new method of SSL (Single Site Location) is presented which makes use of multi-sensor information. Also, unlike conventional SSL methods which generally ray-trace backwards using a single angle of incidence and azimuth, this method uses the incident angles of two or more simultaneous paths (e.g. 1 and 2 hop F2) to determine both an updated ionosphere model at the reflection point(s) and the location of the target transmitter. The angles of azimuth of arrival and elevation are determined using a super-resolution algorithm to decompose the multipath wavefield received on an antenna array. Analytic models are used to approximate the ionosphere and determine propagation paths. If vertical ionospheric sounder data is available, the obtained electron density profile can be fitted using quasi-parabolic segments (MQP model) and parameters of this model optimised in the minimisation procedure. A Nelder Mead simplex algorithm is used for the function minimisation. Greater accuracy in unknown transmitter location can be achieved by including additional constraints in the system such as measured elevation angles of known transmitters. The SSL determination is performed under MATLAB via a menu-driven graphical user interface. This employs pulldown menus for data input, program choice, ionospheric profile plotting and presentation of results.
Author
Transmitters; Multisensor Applications; Multipath Transmission; Ionospheric Sounding; Electron Density Profiles; Antenna Arrays

19980210671 Notre Dame Univ., Dept. of Electrical Engineering, IN United States
SMART ANTENNA ARRAY PROCESSING FOR SPREAD SPECTRUM WIRELESS COMMUNICATION SYSTEMS
Huang, Y. F., Notre Dame Univ., USA; Kapoor, S., Notre Dame Univ., USA; Gollamudi, S., Notre Dame Univ., USA; Nagaraj, S., Notre Dame Univ., USA; Apr. 1998; 10p; In English; See also 19980210650
Contract(s)/Grant(s): NSF MIP-97-05173; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper examines the problem of incorporating smart antennas in wireless DS-CDMA systems. The use of array signal processing in DS-CDMA systems offers the possibility of jointly utilizing code and spatial resources to achieve superior performance compared to conventional multiple-access methods. The development of interference suppression techniques is essential to take full advantage of the available radio resources and requires data fusion in the spatial and code domains. Spatial signal processing can also lead to faster and robust synchronization and provide the capability to rapidly adapt to channel fading, co-channel and adjacent channel interferers. The overall method is suitable for real-time implementation and can lead to a direct increase in the overall capacity, quality and coverage of these systems.
Author
Antenna Arrays; Telecommunication; Wireless Communication; Spread Spectrum Transmission

19980210672 Boston Univ., Center for Space Physics, Boston, MA United States
PROPAGATION DIVERSITY CONSTRAINTS ON RECEPTION OF GPS SIGNALS AT HIGH AND EQUATORIAL LATITUDES
Aarons, Jules, Boston Univ., USA; Lin, Bosheng, Boston Univ., USA; Apr. 1998; 10p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The coming of years of high solar flux, starting in 1999, will bring propagation problems to some users of GPS; we are concerned with ionospheric irregularities which produce phase and amplitude scintillation. The knowledge of when deteriorated signals will occur and their characteristics can help minimize their impact or at least allow users to understand that the fading phenomena are of natural origin rather than equipment related. At equatorial anomaly latitudes, fades of 20 dB at GPS frequencies have been observed in years of high solar flux; according to receiver experts these are enough to disturb any equipment. The sophistication of the equipment in moving through these signal problems is a function of hardware and complexity of software. Knowledge of diversity can help to minimize the effect of temporary loss of signal. The equatorial region irregularity structures are dominated by patches of irregularities which are frequently of the order of 100-200 km in their East West extent. At times these extensions may be exceeded. In addition their effective magnetic North South dimensions may be effective to a few thousand kilometers along the earth's magnetic field. If the altitude that the plume of irregularities reached at the magnetic equator is high, the effects reach the anomaly region with its high electron density and show strong scintillation intensities. New data on the variety of altitudes of irregularities at the equator puts limits on forecasting of some structures but hope for forecasting some major plumes. In the polar region severe problems are not expected to surface until 1999 since polar irregularities have been found to be a function of solar flux. In this area diversity of propagation paths can play an important role. The irregularity region at auroral latitudes is primarily affected by individual magnetic storms which can occur during any phase of the sunspot cycle. Irregularity intensity is a

function of various parameters of the magnetic storm relative to that station. Illustrations of GPS phase fluctuations will be shown as individual storms develop. New data clearly show the forecasting possibilities when using timing of the auroral oval occurrence at a sit as a means of prediction. L Band is to be used in the downlink of new systems proposed and being initiated for personal communications. Low link margins are forecast for several systems to be in the range 6 to 10 dB. These levels indicate that fading due to the ionospheric irregularities such as discussed in these GPS studies will cause problems.
Author
Auroral Zones; Computer Programs; Electron Density (Concentration); Sunspot Cycle; Polar Regions; Magnetic Equator; Magnetic Storms; Solar Flux; Ionospheric Disturbances

19980210673 Naval Air Warfare Center, Geophysics Branch, Point Mugo, CA United States
METEOROLOGICAL DATA FUSION TO ASSESS EM/EO PROPAGATION CONDITIONS IN COASTAL ENVIRONMENTS
Rosenthal, J., Naval Air Warfare Center, USA; Helvey, R., Naval Air Warfare Center, USA; Greiman, P., Naval Air Warfare Center, USA; McGovern, M., Naval Air Warfare Center, USA; Apr. 1998; 7p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

EM/EO propagation conditions can be estimated along specific routes or regions of interest by fusing on one display, the visible satellite imagery showing cloud cover, the operational geometry, and derived quantities such as duct height estimated from the IR duct technique. In addition, by compositing conditions over a set of similar synoptic events, and when also fused with averaged synoptic field gridded data, an average depiction of duct height and associated variability can be obtained. to the extent the cases selected are typical of that type of event, the averaged picture can be used to forecast or estimate the distribution of EM/EO parameters in the near future if confidence exists in the forecast synoptic situation. Additional compositing is underway to broaden the range of synoptic weather types and regions examined.
Author
Meteorological Parameters; Satellite Imagery; Weather; Forecasting; Cloud Cover

19980210681 British Aerospace Public Ltd. Co., Advanced Information Processing Dept., Filton, United Kingdom
COMMUNICATIONS MANAGEMENT IN BATTLESPACE DATA FUSION
Deaves, R. H., British Aerospace Public Ltd. Co., UK; Nicholson, D., British Aerospace Public Ltd. Co., UK; Greenway, P., British Aerospace Public Ltd. Co., UK; Vangasse, P., British Aerospace Public Ltd. Co., UK; Apr. 1998; 9p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Algorithms for managing bandwidth-limited communications links in a multiplatform and multi-target battlespace data fusion scenario are investigated. The platform architecture is modelled on a fully connected decentralised system based on a simplified tactical air warfare scenario. Information on filters on each platform maintain track estimates for each target. These are transmitted around the system in accord with a time-division- multiple-access communications protocal based on JTIDS. Here we address a practical limitations on the communications bandwidth: it unable to support the full set of state information for all of the targets each communications cycle. Strategies must therefore be found to manage the bandwidth. In this paper we consider two different communications management algorithms: (i) a somewhat ad hoc cyclic, or round- robin, algorithm, and (ii) more principled information theoretic algorithm. In general we find that the system has better tracking performance under the information theoretic algorithm than it does for the round-robin algorithm. This result appears to be fairly robust to uncertainties in a transmitting platform's prediction of the state estimates that are currently being maintained at the recipient platforms. In practice since the information theoretic algorithm is more computationally costly to implement than the round-robin algorithm the decision of whether or not to employ intelligent communications management is likely to depend upon the severity of the bandwidth constraint, the number and type of tracked targets,and the predictive power of a platform with regard to other platforms in the network.
Author
Multisensor Fusion; Warfare; Information Theory

19990007857 Marconi S.p.A., Defence Div., Genoa, Italy
INTEGRATED DATA LINK FOR UTA APPLICATIONS: DESIGN CONSIDERATIONS AND DEVELOPMENT RESULTS
Bianchi, L., Marconi S.p.A., Italy; Battaini, G., Marconi S.p.A., Italy; Scazzola, G. L., Marconi S.p.A., Italy; Crovari, E., Marconi S.p.A., Italy; Jul. 1998; 16p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The UTA (Unmanned Tactical Aircraft) or, in general, the UAV (Unmanned Air Vehicle) typical requirements for either non-lethal or lethal tactical missions, imply both the capability to transmit, by means of a Data Link, real-time data (for instance IR, Video, Radar or Navigation Data) and to receive commands (to reprogram partially or completely the mission profile) to/from Ground Stations. The paper faces various aspects related to Data Links for UTA/UAV, presents system considerations and describes the development results obtained with the J Band UAV Data Link realized in Marconi and provided to Italian MoD.
Author
Data Links; Real Time Operation; Ground Stations; Pilotless Aircraft; Superhigh Frequencies

19990007859 Thomson-CSF, Applications Radar, Velizy, France
CRESUS: RADAR PAYLOAD FOR SURVEILLANCE UAVS *CRESUS: CHARGE RADAR EMBARQUEE SUR UAV DE SURVEILLANCE*
Perret, Frederic, Thomson-CSF, France; Hermer, Jean-Michel, Thomson-CSF, France; Gach, Thierry, Thomson-CSF, France; Sicsik-Pare, Emmanuel, Ministry of Defence, France; Jul. 1998; 10p; In French; See also 19990007836; Original contains color Illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Under a contract awarded in 1994 by French MOD (DGA), THOMSON-CSF has developed a demonstrator for a SAR/MTI Air-Ground Surveillance radar on low speed UAVs. After having explained the operational requirement (part 2) and the method used to develop CRESUS (part 3), the principal choices made for CRESUS are explained (part 4), especially the choice of medium range. This range enables one to take advantage, at the maximum possible extent, of the intrinsic features of a radar, that is to say its capability to look through the clouds and, as a direct consequence, its ability to observe from a higher and farther position. A description of MTI and SAR signal processing (Part 5), performances and characteristics (part 6), a physical and functional description (part 7) and a description of the ground segment (part 8) are then given. The conclusion (part 9) emphasizes the versatility of the demonstrator since it can be improved, at low cost, by adding a high resolution SAR mode. Furthermore a low cost installation of the final radar on different classes of UAVs (tactical, MALE, ...) is possible.
Author
Surveillance Radar; Moving Target Indicators; Signal Processing

19990014366 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
PRECISION POINTING AND TRACKING FOR TARGETING/FIRE CONTROL
King, T., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 66-67; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Precision Pointing and Tracking is required in a number of military aerospace electro-optic (E-O) application areas including: air-to-ground E-O targeting; air-to-air sensing and targeting; IR Countermeasures (IRCM) and E-O Countermeasures (EOCM). Performance improvements of at least an order of magnitude are required for weapon systems that will be in service within the 2020 timeframe. The ability to track the target is a function of the sightline dynamic performance and stability, the detector sensitivity and resolution, and the tracking algorithms. The technical requirements for these capabilities are discussed, including: high levels of absolute pointing accuracy, pointing bandwidth, short-term pointing stability and jitter. Among the

various types of solutions discussed, 'inertialess' beam-steering via electro-optic sightline deflectors provides one possible solution to the bandwidth problem. In addition, future improvements will he obtained via algorithms which incorporate 3-D terrain data closely linked to the E-O system.
Author
Weapon Systems; Tracking (Position); Electro-Optics; Electronic Countermeasures; Optical Countermeasures; Precision

19990014370 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
ADAPTIVE REAL-TIME GUIDANCE TECHNIQUES
vanTurennout, P., Advisory Group for Aerospace Research and Development, France; Peters, M. A. G., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 75-77; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

The identification, targeting and kill of critical targets, particularly targets that are mobile, is of extreme importance to the success of missions. To accomplish this, capabilities such as real-time mission (re)planning, location and identification of targets and real-time weapon guidance are required. Technologies needed to accomplish this are real-time data base management, fusion of on/off board data, algorithms for the detection and identification of targets, significant processor and memory capabilities and means to allocate these resources in a flexible manner.
Author
Guidance Sensors; Weapon Systems; Real Time Operation; Target Recognition; Target Acquisition; Multisensor Fusion

19990025710 Department of Defense Health Affairs, Health Services Operations and Readiness, Falls Church, VA United States
MEDICAL GLOBAL COMMAND AND CONTROL SYSTEM
Hughes, S. E., Department of Defense Health Affairs, USA; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

In response to know deficiencies and advances in technology, information systems within the Department of Defense are migrating to compliance with the Defence Information System Agency's (DISA) Defence Information Infrastructure Common Operating Environment to ensure interoperability. The Medical Health Services System (MHSS) has been working to condense its myriad of non-interoperable systems into a family of interoperable systems that meet the needs of all the same architecture protocols as the tactical operational systems. This interoperability will contribute to improved situational awareness, tactical integrity, and command and control while supporting the warfighter.
Derived from text
Command and Control; Medical Services; Telemedicine; Military Operations

33
ELECTRONICS AND ELECTRICAL ENGINEERING

19960003408 Defence Research Establishment Ottawa, Ottawa Ontario, Canada
DESIGN CONSIDERATIONS FOR A SUBOPTIMAL KALMAN FILTER
Difilippo, D. J., Defence Research Establishment Ottawa, Canada; AGARD, Aerospace Navigation Systems; Jun 1, 1995, p 295-311; In English; See also 19960003395; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

In designing a suboptimal Kalman filter, the designer must decide how to simplify the system error model without causing the filter estimation errors to increase to unacceptable levels. Deletion of certain error states and decoupling of error state dynamics are the two principal model simplifications that are commonly used in suboptimal filter design. For the most part, the decisions as to which error states can be deleted or decoupled are based on the designer's understanding of the physics of the particular system. Consequently, the details of a suboptimal design are usually unique to the specific application. In this paper, the process of designing a suboptimal Kalman filter is illustrated for the case of an airborne transfer-of-alignment (TOA) system used for synthetic aperture radar (SAR) motion compensation. In this application, the filter must continuously transfer the alignment of an onboard Doppler-damped master inertial navigation system (INS) to a strapdown navigator that processes information from a less accurate inertial measurement unit (IMU) mounted on the radar antenna. The IMU is used to measure spurious antenna motion during the SAR imaging interval, so that compensating phase corrections can be computed and applied to the radar returns, thereby presenting image degradation that would otherwise result from such motions. The principles of SAR are described in many references, for instance. The primary function of the TOA Kalman filter in a SAR motion compensation system is to control strapdown navigator attitude errors, and to a less degree, velocity and heading errors. Unlike a classical navigation application, absolute positional accuracy is not important. The motion compensation requirements for SAR imaging are discussed in some detail. This TOA application is particularly appropriate as a vehicle for discussing suboptimal filter design, because the system contains features that can be exploited to allow both deletion and decoupling of error states. In Section 2, a high-level background description of a SAR motion compensation system that incorporates a TOA Kalman filter is given. The optimal TOA filter design is presented in Section 3 with some simulation results to indicate potential filter performance. In Section 4, the suboptimal Kalman filter configuration is derived. Simulation results are also shown in this section to allow comparision between suboptimal and optimal filter performances. Conclusions are contained in Section 5.
Author
Design Analysis; Imaging Techniques; Inertial Navigation; Kalman Filters; Onboard Equipment; Radar Imagery; Strapdown Inertial Guidance; Synthetic Aperture Radar

19960003851 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Physics and Electronics Lab., The Hague, Netherlands
PRESENT AND FUTURE TRENDS IN HIGH POWER GENERATION
Vanheijster, Rob M. E. M., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Schouten, Jan M., Naval Electronics and Optics Establishment, Netherlands; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Modern warfare requires high levels of microwave power for various applications. Semiconductors are only suitable for low and medium power levels, for high power generation microwave tubes are the most effective solution. The paper will give an overview of present and future trends in high power microwave systems, based on electron beam tubes.
Author
Electron Beams; High Voltages; Microwave Equipment; Microwave Tubes; Microwaves; Power Supplies; Structural Design; Technological Forecasting; Technology Assessment; Technology Utilization

19960003852 National Defence Headquarters, Ottawa Ontario, Canada
HIGH-POWER MICROWAVE DEVELOPMENT IN RUSSIA
Gauthier, Sylvain, National Defence Headquarters, Canada; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 12 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This is a survey of Russian research and development in high-power microwave (HPM) sources. It emphasizes those sources of nanoseconds pulse duration time which have potential weapon as well as radar applications. It does not cover the whole range of Russian HPM research and development but concentrates on those aspects which may lead to military applications. Russian investigators have achieved many world firsts in HPM generation; for example, a multi-wave Cerenkov generator with a peak output power of 15 gigawatts. Their successes are based on their impressive capability in pulsed power technology which has yielded high-current generators of terawatt peak power. They have transformed the energy of these currents into microwave radiation using tubes of both conventional and novel designs exploiting relativistic electron beams. Recently, the development of high-current mini-accelerators has moved relativistic electron-beam (REB) HPM generation out of the laboratory and enabled the development of deployable military systems with peak powers in the gigawatt range. As a result, they now see development of a REB-

based radar systems as one of the most promising directions in radar systems. Details of such a system are described and the implications for HPM weapons are considered.
Author
Cerenkov Counters; Dielectrics; Masers; Microwaves; Oscillators; Plasma Display Devices; Radar Equipment; Relativistic Electron Beams; Russian Federation

19960003853 New Mexico Univ., Dept. of Electrical and Computer Engineering., Albuquerque, NM, United States
HIGH EFFICIENCY BACKWARD-WAVE OSCILLATORS FOR HIGH POWER MICROWAVE GENERATION: PRESENT STATUS AND FUTURE TRENDS
Schamiloglu, E., New Mexico Univ., USA; Gahl, J., New Mexico Univ., USA; Fleddermann, C., New Mexico Univ., USA; Shiffler, D., New Mexico Univ., USA; Fleddermann, C., New Mexico Univ., USA; Shiffler, D., New Mexico Univ., USA; Moreland, L., New Mexico Univ., USA; Grabowski, C., New Mexico Univ., USA; Cavazos, T., New Mexico Univ., USA; Wroblewski, B., New Mexico Univ., USA; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 7 p; In English
Contract(s)/Grant(s): F49620-94-1-0087; F49620-93-1-0585; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The efficiency of high peak power microwave generation in vacuum X-band backward-wave oscillators is described. Nonuniform slow wave structures are driven by the Sinus-6, a short pulse, repetitive relativistic electron beam accelerator. Peak microwave power exceeding 500 MW at 9.45 GHz has been measured in an 8 ns pulse. The corresponding beam-to-microwave power conversion efficiency was 17%, although efficiencies approaching 25% have been achieved at lower power levels. The ability to acquire a large amount of data using the Sinus-6 accelerator facilitates comparisons with electromagnetic particle-in-cell simulations and analytical theories. In a companion set of experiments, a modified PI-110A single shot electron beam accelerator is used to study backward-wave oscillators with parameters comparable to the Sinus-6 experiments, except at pulse durations approaching 0.5 microsecs. The goal of these studies is to extend the duration of microwave generation in high power backward-wave oscillators to several hundreds of nanoseconds. Technological innovations, such as ferroelectric cathodes and thin film metallic coatings, are expected to yield significant advances in long pulse operation.
Author
Backward Waves; Electron Accelerators; Energy Conversion Efficiency; Microwave Oscillators; Power Efficiency; Relativistic Electron Beams; Technological Forecasting; Technology Utilization; Vacuum Systems

19960003854 Naval Research Lab., Plasma Physics Div., Washington, DC, United States
APPLICATIONS OF RELATIVISTIC KLYSTRON AMPLIFIER TECHNOLOGY
Friedman, M., Naval Research Lab., USA; Serlin, V., Naval Research Lab., USA; Lampe, M., Naval Research Lab., USA; Hubbard, R., Naval Research Lab., USA; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 9 p; In English; Sponsored by ONR; and BMDO-IST/HDL; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Over the past decade, development of the relativistic klystron amplifier (RKA) at NRL boosted high power microwave (HPM) technology by an order of magnitude. RKA has set world records in peak RF power generation. Using RKA's, microwave power in excess of 10 GW has been generated, at a frequency of 1.3 GHz and with energy of 1 kJ per pulse. Even though the NRL RKA constitutes a major advance over previous HPM technology, practical applications continue to be limited by size, cost and immobility of the equipment; relatively low efficiency (35%); breakdown at high power level, particularly in the output gaps; and unfavorable power scaling at frequencies above 1 GHz. However, we developed plans for a new generation of RKAs that will leapfrog all of these limitations, providing a technology with the following characteristics: (1) compact, cheap, and efficient; (2) avoiding gap breakdown; and (3) equally efficient from .5 to 10 GHz (greater than 75%).
Author
Klystrons; Magnetic Amplifiers; Microwave Emission; Relativistic Electron Beams; Technological Forecasting; Technology Utilization

19960003856 University Coll., Cardiff, United Kingdom
INVESTIGATIONS INTO SUB-NS PULSE GENERATION USING FERRITE-LOADED COAXIAL LINES
Bolton, H. R., University Coll., UK; Dolan, J. E., University Coll., UK; Shapland, A. J., University Coll., UK; Parkes, D. M., Defence Research Agency, UK; Trafford, K., Defence Research Agency, UK; Kerr, B., Defence Research Agency, UK; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 9 p; In English; Sponsored by Defence Research Agency; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Systems such as Pockels Cell drivers and UWB radar require electrical pulses of less than 200 ps rise-time and amplitude of 10 kV or greater into 50 ohms. Desired p.r.f.'s may be 50 kHz or higher in burst mode. The output rise-time of high power and p.r.f. capable pulsers is generally of the order 2-20 ns, and ferrite-loaded coaxial lines are one means of reducing the leading edge 10-90% rise-time to the order of 100-200 ps. The development of the fast-rising leading edge in ferrite lines is due to the non-linearity of the magnetic medium, and the consequent formation of an 'electromagnetic shock front' at the pulse leading edge. Over the past decade, the use of magnets to bias the ferrite has been found to improve output rise-time and amplitude characteristics considerably. Steady-state analyses made by Soviet analysts in the 1960's do not explain the magnet-biased ferrite line characteristics, and a numerical approach will be presented which shows how the microwave characteristics of the ferrite may be combined with the TEM transmission line equations to model electromagnetic shock wave propagation in such ferrite-loaded lines. It now appears reasonably clear that ferrite lines may be effectively modelled and designed in terms of parameters including the ferrite saturation magnetisation, and the dimensions of the line and the ferrite beads. Second order effects such as conductor and dielectric losses may also be taken into account if required.
Author
Coaxial Flow; Electromagnetic Wave Transmission; Ferrites; Magnets; Shock Fronts; Shock Wave Propagation; Technology Assessment; Transmission Lines

19970001706 Pennsylvania State Univ., Dept. of Engineering Science and Mechanics and Electrical Engineering, University Park, PA United States
SMART STRUCTURES, MEMS AND SMART ELECTRONICS FOR AIRCRAFT
Varadan, Vijay K., Pennsylvania State Univ., USA; Varadan, Vasundara V., Pennsylvania State Univ., USA; Oct. 1996; 20p; In English; Sponsored by Army Communications-Electronics Command, USA; See also 19970001697; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

In this paper, the integration of multifunctional smart materials, Micro-Electro-Mechanical Systems (MEMS) and smart electronics is presented with examples covering smart structures and devices applicable to aircraft. Some applications include systems for (a) noise suppression in aircraft cabin using 'smart wall paper', (b) drag sensing and reduction in aircraft, (c) sensing and control of ice formation and deicing on aircraft, (d) remote measurement of tip deflection of helicopters using MEMS sensor and electronically tunable antenna, (e) smart skin antenna for communication between sensors and actuators (telemetry device), and (f) health monitoring of rotorcrafts using MEMS sensors along with fiber optics sensor and remote antenna system.
Author
Smart Structures; Shape Memory Alloys; Helicopters; Drag Reduction; Remote Control

19970006928 GF-Sistemi Avionici, Turin, Italy
VLSI IMPLEMENTATION OF A CHIP FOR A SYSTOLIC ARRAY ARCHITECTURE FOR DIRECTION FINDING SYSTEMS
Audone, B., GF-Sistemi Avionici, Italy; Bresciani, F., GF-Sistemi Avionici, Italy; Zerlottin, D., Modulo Uno, Italy; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Recently a new class of so-called subspace methods for high resolution direction finding has received a great deal of attention in the literature. In this paper a new processor designed for parallel filter structure (systolic array) is presented. The processor is a single chip VLSI implementation of an electronic board for systolic array which computes the QR, the SVD, and the generalized Schur decomposition

(GSD) of a complex matrix. The array utilizes coordinate rotation digital computer (CORDIC) arithmetic to perform the vector rotations and inverse tangent calculation in hardware. The resulting architecture is a two layer Jacobi array that can handle all the subproblems for solving direction finding problems. This component will be used for a direction finding system of advanced characteristics to be installed on airborne platforms. The main advantages of the high resolution technique consist in improved resolution (because it can overcome the limitations of the Rayleigh criterion) and in the possibility of detecting sources located in different positions and emitting signals at the same frequency.
Author
Direction Finding; Matrices (Mathematics); Airborne Equipment; Radio Direction Finders; Systolic Arrays

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FLUID MECHANICS AND HEAT TRANSFER

19960003582 Technical Univ. of Denmark, Dept. of Fluid Mechanics., Lyngby, Denmark
A VISCOUS-INVISCID INTERACTION MODEL FOR ROTOR AERODYNAMICS
Filippone, A., Technical Univ. of Denmark, Denmark; Sorensen, J. N., Technical Univ. of Denmark, Denmark; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 10 p; In English; See also 19960003572; Sponsored in part by CIRA S.p.A.; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper presents a numerical model for viscous-inviscid interactive computations of rotor flows. The model presented is fairly general, as it allows for both steady and unsteady calculations. The basic methodology for deriving the outer inviscid solution is a fully three-dimensional boundary element method. The inner viscous domain, i.e. the boundary layer, is described by the two-dimensional Navier-Stokes equations. For the interactive procedure a blade strip approach is used. The outer inviscid solution provides the distribution of induced velocities to be used as boundary condition for the Navier-Stokes solver. The outer solution is then updated with new boundary conditions, arising from the viscous effects. For unsteady flow calculations a time marching procedure is used. Some preliminary results are presented for the rotor blade of a wind turbine.
Author
Boundary Element Method; Computational Fluid Dynamics; Inviscid Flow; Navier-Stokes Equation; Rotor Aerodynamics; Time Marching; Turbine Blades; Unsteady Flow; Velocity Distribution; Viscous Flow; Wind Turbines

19960003587 Textron Bell Helicopter, Fort Worth, TX, United States
COMPUTATIONAL FLUID DYNAMICS DEVELOPMENT AND VALIDATION AT BELL HELICOPTER
Narramore, J. C., Textron Bell Helicopter, USA; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 13 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

An overview of the development of the Computational Fluid Dynamics (CFD) methodology at Bell Helicopter Textron is given. As new technologies have been developed their functionality has been assessed by their ability to reproduce wind tunnel measurements in a timely manner. Examples of some of these correlation study results are provided.
Author
Aerodynamic Drag; Angle of Attack; Computational Fluid Dynamics; Data Correlation; Dynamic Pressure; Flow Visualization; Helicopters; Lift; Navier-Stokes Equation; Pitching Moments; Rotor Aerodynamics

19960003874 New Mexico State Univ., Dept. of Physics., Las Cruces, NM, United States
MICRON-SIZED DROPLETS IRRADIATED WITH A PULSED CARBON DIOXIDE LASER: MEASUREMENT OF EXPLOSION AND BREAKDOWN THRESHOLDS
Armstrong, R. L., New Mexico State Univ., USA; Biswas, A., New Mexico State Univ., USA; Pinnick, R. G., Army Research Lab., USA; Pendleton, J. D., Army Research Lab., USA; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 11 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

We present the results of measurements of explosive vaporization and plasma breakdown thresholds of micron-sized droplets irradiated by a pulsed CO2 laser operating at 10.6 microns. Well-defined explosion and breakdown patterns are observed when the incident laser intensity exceeds the threshold value. In the infrared region, the breakdown threshold is larger than the vaporization threshold by a factor of approximately 10(exp 2). Although, to the authors knowledge, no analogous measurements of vaporization and breakdown thresholds of individual aerosol particles exist in the microwave region, scaling of our infrared measurements to deduce the corresponding microwave properties is possible using available theoretical models. When this scaling is performed, it suggests that a dramatic reversal of explosion and breakdown thresholds occurs in the microwave region. In this region, the microwave vaporization threshold is larger than the corresponding breakdown threshold by a factor of greater than 10(exp 4). Recent measurements of breakdown thresholds in aerosol-laden air provide indirect evidence that this reversal has, in fact, taken place.
Author
Aerosols; Drops (Liquids); Infrared Absorption; Ionization; Laser Beams; Superheating; Vaporizing

19960003876 Phillips Lab., Kirtland AFB, NM, United States
CRITICAL HEAT FLUX PANEL EXPERIMENTS
Beraun, J. E., Phillips Lab., USA; Raymond, K. F., Phillips Lab., USA; Orlins, J. S., Phillips Lab., USA; Rigby, F. A., Phillips Lab., USA; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 11 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Phillips Laboratory's Laser Effects Branch, PL/WSAE, performs laser interaction experiments on a wide range of materials, components, and subsystems, to understand the physics of interaction at high heating rates and to explore for any synergistic phenomenology in components and subsystems. This paper covers one such recently completed project: Critical Heat Flux Panel Experiments. The goal of the Critical Heat Flux Panel Experiments is to determine the necessary threshold laser irradiance to induce film boiling on the inside surface of a fuel tank. Film boiling describes the phenomena whereby a thin continuous vapor layer is formed on the heated surface, such as the inside surface of a fuel tank, and effectively insulates the wall from the liquid within. Film boiling, once established, interferes with heat transfer by insulating the wall from the liquid, which allows laser energy to remain within the wall raising its temperature quickly to failure level. At heating rates below those required for film boiling, vapor bubbles form and detach continuously from the heated surface, a process referred to as nucleate boiling. This leaves both plenty of liquid in contact with the wall and actually stirs up the liquid providing massive heat transfer from the wall. Thus, nucleate boiling is a very effective heat transfer mechanism. The Critical Heat Flux Panel Experiments have successfully established laser irradiance thresholds for achieving film boiling and ultimate failure of a metal tank. This paper describes in detail test design and special procedures utilized for this test series. The paper also presents experimental results and its implications to theoretical models.
Author
Critical Experiments; Film Boiling; Fuel Tanks; Heat Flux; Heat Transfer; Irradiance; Laser Beams; Low Pressure; Nucleate Boiling

19960009082 Katholieke Univ. te Leuven, Dept. of Computer Science.; **Belgium**
PARALLEL COMPUTERS AND PARALLEL ALGORITHMS FOR CFD: AN INTRODUCTION
Roose, Dirk, Katholieke Univ. te Leuven, Belgium; Vandriessche, Rafael, Katholieke Univ. te Leuven, Belgium; AGARD, Special Course on Parallel Computing in CFD; Oct 1, 1995, 23 p; In English; See also 19960009081; Avail: CASI; A03, Hardcopy; A03, Microfiche

This text presents a tutorial on those aspects of parallel computing that are important for the development of efficient parallel algorithms and software for computational fluid dynamics. We first review the main architectural features of parallel computers and we briefly describe some parallel systems on the market today. We introduce some important concepts concerning the development and the performance evaluation of parallel algorithms. We discuss how work load imbalance and communication costs on distributed memory parallel computers can be minimized. We present performance results

for some CFD test cases. We focus on applications using structured and block structured grids, but the concepts and techniques are also valid for unstructured grids.
Author (revised)
Algorithms; Computational Fluid Dynamics; Parallel Computers; Parallel Processing (Computers)

19960009083 Katholieke Univ. te Leuven, Dept. of Computer Science.; **Belgium**
LOAD BALANCING COMPUTATIONAL FLUID DYNAMICS CALCULATIONS ON UNSTRUCTURED GRIDS
Vandriessche, Rafael, Katholieke Univ. te Leuven, Belgium; Roose, Dirk, Katholieke Univ. te Leuven, Belgium; AGARD, Special Course on Parallel Computing in CFD; Oct 1, 1995, 26 p; In English; See also 19960009081; Avail: CASI; A03, Hardcopy; A03, Microfiche

Efficient use of a parallel computer requires the data and the operations that must be performed on them to be distributed over the processors in such a way that the work load is balanced and the communication cost minimized. This distribution problem is called the load balancing problem. For CFD applications, the load balancing problem amounts to finding a partition of the grid and subsequently a mapping of the subgrids to the processors, that balance the work load and minimize the communication costs. This tutorial contains a description of well-established methods for partitioning and mapping unstructured grids. They range from simple heuristics, over global optimization methods to very powerful and cost-effective algorithms that combine the strengths of simpler heuristics. Most of the methods that will be discussed, have been implemented in some well-documented and -supported partitioning tools. The tutorial discusses two of the most important ones: Chaco and TOP/DOMDEC.
Author
Algorithms; Computational Fluid Dynamics; Parallel Processing (Computers); Partitions (Mathematics); Unstructured Grids (Mathematics)

19960022328 Wright Lab., Weapon Flight Mechanics Div., Eglin AFB, FL United States
PRACTICAL USE OF COMPUTATIONAL FLUID DYNAMICS IN STORES CLEARANCES
Simpson, L. Bruce, Wright Lab., USA; Aerodynamics of Store Integration and Separation; Feb. 1996; 10p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A description in the use of Computational Fluid Dynamics (CFD) for Stores clearance analysis is provided. CFD provides an accurate assessment of both steady and unsteady aerodynamics needed for stores clearance analysis. CFD is used for store carriage loads and separation analysis. Results are shown for both types of analysis and conclusions are drawn regarding the future trend of CFD for stores clearance.
Author
Clearances; External Store Separation; Computational Fluid Dynamics; Aerodynamic Loads; Computer Programs

19960022332 Victoria Univ. of Manchester, Dept. of Aerospace Engineering., United Kingdom
AN EVALUATION OF ADVANCED CFD CODES FOR STORES AT INCIDENCE
Sellars, N. D., Victoria Univ. of Manchester, UK; Hall, I. M., Victoria Univ. of Manchester, UK; Feb. 1996; 10p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Computer codes solving the Euler Equations have been used to calculate the flow around a series of non-circular store bodies at transonic Mach numbers. Where possible Navier-Stokes solutions have been compared with these results. Four different cross-sections have been considered which are formed by gradually transforming a square into a circle by rounding the corners. Each of the stores has a tangent ogive nose. Both the full three dimensional solutions around these stores and the two dimensional crossflow solutions have been investigated. The particular interest has been in the capability of Euler codes to predict crossflow separation. The results obtained show that for some cases, Euler codes can provide an inexpensive alternative to Navier-Stokes codes for use as an initial design tool.
Author
Computational Fluid Dynamics; Computer Programs; External Stores; Aerodynamic Configurations; Numerical Flow Visualization; Flow Distribution

19960022333 Istanbul Univ., Faculty of Aeronautics and Astronautics., Turkey
AERODYNAMICS OF FUSELAGE AND STORE-CARRIAGE INTERACTION USING CFD
Gulcat, Ulgen, Istanbul Univ., Turkey; Aslan, A. Rustem, Istanbul Univ., Turkey; Misirhoglu, Aydm, Istanbul Univ., Turkey; Feb. 1996; 10p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Store-carriage, pylon, fuselage interaction problem for modelling part of a fuselage of a fighter aircraft in low Mach number flight is studied by solving the full Navier-Stokes Equations numerically. A Finite Element Method (FEM) with an explicit time marching scheme is used for the solution. An artificial viscosity, equivalent of streamwise upwinding, is implemented while obtaining the velocity field. The pressure field is determined via an auxiliary potential function obtained with an accelerated iterative solution of Poissons' equation. Comparison of the pressure distributions and aerodynamic force coefficients obtained by the code for various test cases has validated the code. Therefore the code is utilized for more complex flow predictions.
Author
External Stores; Aerodynamic Characteristics; Fuselages; Computational Fluid Dynamics; Navier-Stokes Equation; Aerodynamic Configurations; Finite Element Method; Prediction Analysis Techniques; Flow Distribution

19960022343 Glasgow Univ., Dept. of Aerospace Engineering., United Kingdom
NAVIER-STOKES SOLUTIONS OF TURBULENT TRANSONIC CAVITY FLOWS
Tracey, J. L., Glasgow Univ., UK; Richards, B. E., Glasgow Univ., UK; Feb. 1996; 10p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A code has been developed to model the flow over cavities. An implicit, finite volume technique is used to solve the two and three dimensional Navier-Stokes equations. Turbulence is modelled using the Baldwin-Lomax model with the Degani-Schiff modification. Solutions are presented for two test cases, the results of which are compared with experimental data and Rossiter's model.
Author
Navier-Stokes Equation; Transonic Flow; Turbulent Flow; Cavity Flow; Finite Volume Method; Computational Fluid Dynamics

19960022347 Istanbul Univ., Dept. of Mechanical Engineering., Turkey
UNSTEADY SUBSONIC AERODYNAMICS FOR MANEUVERING WING/FUSELAGE/PYLON/STORE CONFIGURATION AND STORE SEPARATION INCLUDING WAKE EFFECTS
Kaykayoglu, C. Ruhi, Istanbul Univ., Turkey; Yalcinel, Murat, Turkish Air Force Academy, Turkey; Feb. 1996; 14p; In English; See also 19960022326; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A Computational Fluid Dynamics (CFD) technique based on a Vortex Lattice Method (VLM) is presented for treating the unsteady, low speed aerodynamics of a Wing/Fuselage/ Pylon/Store (W/F/P/S) combination in an incompressible flow. The main emphasis is placed on a practical, cost-effective engineering solution of the complex problem with a reasonable computational efficiency allowing the computer code to run on small personal computers. The computational model presented in this study enables the calculation of the unsteady aerodynamic forces acting on a wing system undergoing a time dependent three dimensional motion. An unsteady, wing following and wake shedding procedure provides the transient wake shapes. Computed flow field simulations are presented for various unsteady and angle of attack conditions involving pylon/store locations at various spanwise locations under the wing. The external store separation under the influence of the unsteady wake rollup behind the

wing system is modeled by considering the full mutual interaction between the store and the W/F/P configuration. The results show that the method is capable of simulating the important features of the unsteady forces and wake development behind the W/F/P/S configuration.
Author
Unsteady Aerodynamics; External Store Separation; Wakes; Vortex Lattice Method; Aerodynamic Configurations; Incompressible Flow; Aerodynamic Forces; Subsonic Speed; Subsonic Flow

19960024835 Ecole Centrale de Lyon, Lab. de Mecanique des Fluides et d'Acoustique., France
UNSTEADY FLOW AMPLIFICATION PRODUCED BY UPSTREAM OR DOWNSTREAM DISTURBANCES *AMPLIFICATION DES INSTATIONNARITES GENEREES PAR DES PERTURBATIONS AMONT OU AVAL*
Ferrand, P., Ecole Centrale de Lyon, France; Atassi, H. M., Notre Dame Univ., USA; Aubert, S., Ecole Centrale de Lyon, France; Jan. 1996; 10p; In French; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

In order to avoid or minimize the fluctuating forces resulting from unsteady flow-structure interaction, one tries to identify the important parameters which affect the level of these excitations. A subsonic and transonic convergent/divergent nozzle is used to analyze the unsteady flow near sonic conditions. Analytical and numerical computations using unsteady linear and nonlinear Euler equations are carried out to analyze and quantify the upstream and downstream propagation of acoustic disturbances in the nozzle. The results show that, when the mean flow Mach number is close to unity, only upstream propagating acoustic disturbances are strongly amplified. It is therefore proposed to explain this phenomenon as resulting from the blockage of upstream propagating acoustic waves by near transonic mean flow. These results are confirmed on cascade configuration. A unsteady pressure bulge, near the sonic area, is found to be associated with the cut-on of a new acoustic mode in the upstream direction. The level of the pressure bulge is significantly reduced as a downstream propagating mode cuts on. These results confirm the phenomenon of acoustic blockage.
Author
Acoustic Nozzles; Euler Equations of Motion; Transonic Nozzles; Unsteady Flow; Nozzle Geometry; Turbomachinery

19960024836 Ecole Centrale de Lyon, France
MODELS FOR CALCULATING THE THREE DIMENSIONAL FLUCTUATIONS IN THE FRAMEWORK OF CENTRAL FLOW OF A TURBINE ENGINE *MODELES POUR LE CALCUL DE FLUCTUATIONS SPATIALES TRIDIMENSIONNELLES DANS LE CADRE D'UNE APPROCHE MERIDIENNE EN TURBOMACHINE*
Perrin, G., Ecole Centrale de Lyon, France; Leboeuf, F., Ecole Centrale de Lyon, France; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 10p; In French; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

The compatibility between three dimensional simulations with Euler or Navier-Stokes equations, and through flow computations, may be satisfied by taking into account spatial fluctuation terms in the conservation equations of momentum and energy. This method has been little explored in order to determine the losses or work variations in a machine. A model for the computation of these spatial fluctuation terms is presented. The test of the model is performed for a steady flow in a low speed turbine cascade.
Author
Three Dimensional Flow; Computational Fluid Dynamics; Turbine Engines; Cascade Flow; Steady Flow

19960047286 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
TURBULENT BOUNDARY LAYERS IN SUBSONIC AND SUPERSONIC FLOW *LES COUCHES LIMITES TURBULENTES DANS LES ECOULEMENTS SUBSONIQUES ET SUPERSONIQUES*
Saric, William S., Editor, Arizona State Univ., USA; Dussauge, J. P., Institut de Recherche sur les Phenomenes Hors d'Equilibre, France; Smith, R. W., Applied Research Labs., USA; Smits, A. J., Princeton Univ., USA; Fernholz, H., Technische Hochschule, Germany; Finley, P. J., Imperial Coll. of Science and Technology, UK; Spina, Eric F., Syracuse Univ., USA; Jul. 1996; 84p; In English
Report No.(s): AGARD-AG-335; ISBN 92-836-1040-7; Copyright Waived; Avail: CASI; A05, Hardcopy; A01, Microfiche

Current research on the structure of zero pressure gradient, flat plate turbulent boundary layers is reviewed. The behavior of boundary layers in subsonic and supersonic flow is discussed, with a particular emphasis on scaling laws with respect to Reynolds number and Mach number. For subsonic flows, it is shown that for the mean flow the classic arguments on inner and outer layer similarity hold extremely well over a large range of Reynolds numbers (approximately 350 less than or equal to R(sub e(theta)) greater than or equal to 210,000), and the overlap region is well established over the same region. In contrast, the Reynolds number can have a significant effect on the level of the maximum turbulence stresses, and the location of that maximum in the boundary layer. In particular, the streamwise scaling of the outer-layer is rather sensitive, where the scale increases with the Reynolds number. For supersonic flows with moderate Mach number, it appears that the direct effects of compressibility on wall turbulence are rather small: the most notable differences between subsonic and supersonic boundary layers may be attributed to the variation in fluid properties across the layer. However, certain characteristics cannot be collapsed by simple scaling. Among other observations, there exists strong evidence to indicate that the streamwise length scales are reduced significantly by increasing Mach number.
Author
Subsonic Flow; Supersonic Flow; Turbulent Boundary Layer; Scaling Laws; Reynolds Number; Mach Number

19960053167 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
PROGRESS AND CHALLENGES IN CFD METHODS AND ALGORITHMS *PROGRES REALISES ET DEFIS EN METHODES ET ALGORITHMES (CFD)*
Apr. 1996; 454p; In English; In French; 77th; Fluid Dynamics Panel Symposium, 2-5 Oct. 1995, Seville, Spain; See also 19960053168 through 19960053204; Original contains color illustrations
Report No.(s): AGARD-CP-578; ISBN 92-836-0026-6; Copyright Waived; Avail: CASI; A20, Hardcopy; A04, Microfiche

The papers prepared for the AGARD Fluid Dynamics Panel (FDP) Symposium on 'Progress and Challenges in Computational Fluid Dynamics (CFD) Methods and Algorithms', which was held 2-5 October 1995 in Seville, Spain are contained in this report. In addition, a Technical Evaluator's Report aimed at assessing the success of the Symposium in meeting its objectives, and an edited transcript of the General Discussion held at the end of the Symposium are also included. Papers presented during nine sessions addressed the following subjects: - parallel computing; - advanced spatial descretization techniques; - unstructured, hybrid and overlapping grids; - adaptive meshes; - fast implicit and iterative solvers; - large eddy and direct numerical simulations of turbulent flows; - chemically reacting flows; - unsteady aerodynamics.
Author
Algorithms; Computational Fluid Dynamics; Conferences; Parallel Processing (Computers); Computational Grids; Vortices; Navier-Stokes Equation

19960053168 Princeton Univ., Dept. of Mechanical and Aerospace Engineering., NJ United States
THE PRESENT STATUS, CHALLENGES, AND FUTURE DEVELOPMENTS IN COMPUTATIONAL FLUID DYNAMICS
Jameson, Antony, Princeton Univ., USA; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 38p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents a perspective on computational fluid dynamics (CFD) as a tool for aircraft design. It addresses the requirements for effective industrial use, and trade-offs between modeling accuracy and computational costs. Issues in algorithm design are discussed in detail, together with a unified approach to the design of shock capturing algorithms. Finally, the paper discusses the use of techniques drawn from control theory to determine optimal aerody-

namic shapes. In the future, multidisciplinary analysis and optimization should be combined to provide an integrated numerical design environment.
Author
Aircraft Design; Computational Fluid Dynamics; Algorithms; Multidisciplinary Design Optimization; Aerodynamic Characteristics; Computational Grids; Computer Aided Design

19960053169 Boeing Commercial Airplane Co., Seattle, WA United States
CFD RESEARCH IN THE CHANGING US AERONAUTICAL INDUSTRY
Rubbert, Paul E., Boeing Commercial Airplane Co., USA; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper analyzes the workings of the research engine and finds that it is encountering considerable strain. Resources for all elements of research are below historic levels. 'Money givers' are faced with a lack of metrics and infrastructure for telling them how to invest their resources except in high level terms. Leaders of research are having to redefine their jobs. Researchers are hunkered down to wait it out. and value systems are in disarray and conflict. The adaptation of the research engine to the changing world is far from complete. It is in transition. The paper goes on to describe what the author believes to be the principal characteristics and attributes of a well functioning research engine, together with a few personal experiences that shed some light on how those attributes can be achieved. He concludes that further adaptation of the research engine will be paced by two key factors. One is the need to change the types of communication that take place between the research community and the engineering community in industry. The other is the need to unshakle the minds of researchers from the imprisonment of an overly narrow value system, a task which must be led by the money givers who inhabit the research engine.
Author
Computational Fluid Dynamics; Aerospace Industry; Algorithms; Research and Development; Budgeting; Multidisciplinary Research; User Requirements; Research Management

19960053170 Rutgers - The State Univ., Dept. of Mechanical and Aerospace Engineering, Piscataway, NJ United States
PARALLEL COMPUTING IN COMPUTATIONAL FLUID DYNAMICS
Knight, Doyle D., Rutgers - The State Univ., USA; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 14p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents an overview of parallel computing in computational fluid dynamics (CFD). A taxonomy of parallel computing architecture and programming paradigms is described. Issues in parallel computing are discussed including domain decomposition and load balancing, performance, scalability, benchmarks and portability. Examples of experience with parallel computing in the aerospace industry are described.
Author
Aerospace Industry; Computational Fluid Dynamics; Parallel Processing (Computers); Architecture (Computers); Software Development Tools; Research and Development; MIMD (Computers)

19960053171 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany
PORTABLE PARALLELIZATION OF A 3D EULER/NAVIER-STOKES SOLVER FOR COMPLEX FLOWS
Eisfeld, B., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Ritzdorf, H., Gesellschaft fuer Mathematik und Datenverarbeitung, Germany; Bleecke, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Kroll, N., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes the portable parallelization of the FLOWer code, a large block structured computational fluid dynamics (CFD) solver for industrial use. Basic requirements for the parallelization are identified, and the strategies applied for its parallelization are explained. Special emphasis is put on the parallel heart of the program, the communications library CLIC-3D. Results obtained on several platforms demonstrate the success of the method chosen and allow an assessment of today's capabilities of parallel computers in CFD applications. Parallel computations of aircraft configurations of varying complexity prove that parallel computers have become operational in aircraft development.
Author
Aircraft Design; Computational Fluid Dynamics; Navier-Stokes Equation; Parallel Computers; Computer Aided Design; Parallel Processing (Computers); Computer Systems Performance

19960053172 Universidad Politecnica de Madrid, Madrid, Spain
A PARALLEL SPECTRAL MULTI-DOMAIN SOLVER SUITABLE FOR DNS AND LES NUMERICAL SIMULATION OF INCOMPRESSIBLE FLOWS
Pinelli, A., Universidad Politecnica de Madrid, Spain; Vacca, A., Universidad Politecnica de Madrid, Spain; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 8p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In the present paper we introduce and discuss an efficient parallel algorithm for the spectral multi-domain solution of incompressible Navier-Stokes equations. First, the algorithm is given in its basic form for the 2-dimensional case and, later on, a possible extension to 3-dimensional flows exhibiting a homogeneous (periodic) direction is proposed. The algorithm is validated both for its parallel performance and its accuracy.
Author
Algorithms; Incompressible Flow; Navier-Stokes Equation; Computational Fluid Dynamics; Parallel Processing (Computers); Spectral Theory; Computer Programs

19960053173 Minnesota Univ., Aerospace Engineering and Mechanics, Minneapolis, MN United States
ON IMPROVING PARALLELISM IN THE TRANSONIC UNSTEADY ROTOR NAVIER STOKES (TURNS) CODE
Wissink, Andrew M., Minnesota Univ., USA; Lyrintzis, Anastasios S., Purdue Univ., USA; Strawn, Roger C., Army Aviation Systems Command, USA; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167
Contract(s)/Grant(s): DAAL03-89-C-0038; NSF CCR-94-96327; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A parallel implementation of the three dimensional transonic unsteady rotor Navier-Stokes (TURNS) rotorcraft flow solver is studied. We investigate two modifications of the LU-SGS operator to improve parallel performance. The first is the Data-Parallel LU Relaxation (DP-LUR) technique. This operator uses a Jacobi sweeping procedure in place of the Gauss-Seidel sweeps in LU-SGS. The resulting algorithm is very amenable to parallel processing but requires significantly more computational work. The second approach is a hybrid technique which maintains the nearest neighbor communication patterns of DP-LUR but uses the more efficient Gauss-Seidel sweeps of LU-SGS for the on-processor computations. The TURNS code, with the DP-LUR and hybrid operators, is implemented on the massively parallel Thinking Machines using a multiple instruction/ multiple data (MIMD) (i.e. requiring message passing) approach. The convergence qualities and the central processing unit (CPU) time of the two implicit operators are studied for an example calculation, comparing the quasi-steady three dimensional flow field around a helicopter blade with subsonic and transonic tip Mach numbers. Both the DP-LUR and hybrid modifications of LU-SGS show very good parallelism, and maintain the convergence rate of LU-SGS. However, the hybrid method uses less overall CPU time than DP-LUR.
Author
Algorithms; Three Dimensional Flow; Rotary Wing Aircraft; Massively Parallel Processors; Flow Distribution; Parallel Processing (Computers); Response Time (Computers); Computational Fluid Dynamics; Navier-Stokes Equation

19960053174 Porto Univ., Faculdade de Engenharia, Portugal
DEVELOPMENT OF A PARALLEL IMPLICIT ALGORITHM FOR CFD CALCULATIONS
dAlmeida, F. Dias, Porto Univ., Portugal; Castro, F. A., Porto Univ., Portugal; Palma, J. M. L. M., Porto Univ., Portugal; Vasconcelos, P., Porto Univ., Portugal; Progress and Challenges in CFD Methods and Algo-

rithms; Apr. 1996; 8p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The present article reports on further developments of an implicit coupled algorithm for fluid flow equations. Mass and momentum conservation equations are solved as part of one large system of equations in one simple step. Iterations are needed because of nonlinearities only. The algorithm requires no under-relaxation factors and can reach convergence in a reduced number of iterations, compared to decoupled approaches. This article describes improvements leading to reduction of both memory and computing time. The algorithm exceeds the memory requirements of the SIMPLE algorithm of Patankar and Spalding by a factor of K(exp 2), where K is the number of independent variables. Computing time reduction was achieved by using GMRES and a preconditioner based on incomplete LU factorization. The algorithm compares favorably with conventional de-coupled approaches. to overcome the high memory requirements and enable the simulation of large physical problems two different approaches for parallelization were also tested, at the expense of increased computing time.

Author

Algorithms; Computational Fluid Dynamics; Iterative Solution; Computerized Simulation; Parallel Processing (Computers); Response Time (Computers)

19960053175 Rockwell International Science Center, Thousand Oaks, CA United States

EXPERIMENTS WITH UNSTRUCTURED GRID COMPUTATIONS

Ramakrishnan, S. V., Rockwell International Science Center, USA; Szema, K. Y., Rockwell International Science Center, USA; Chen, C. L., Rockwell International Science Center, USA; Shankar, V. V., Rockwell International Science Center, USA; Chakravarthy, S. R., Rockwell International Science Center, USA; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 8p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes work done at Rockwell Science Center on the development and application of computational fluid dynamics (CFD) solvers for unstructured grids. A description of the use of 'interior boundary' conditions in simulating moving bodies is also presented.

Author

Boundary Conditions; Computational Fluid Dynamics; Unstructured Grids (Mathematics); Computer Programs; Algorithms; Navier-Stokes Equation

19960053176 Liege Univ., Aerodynamics Group, Belgium

A SECOND-ORDER FINITE-VOLUME SCHEME SOLVING EULER AND NAVIER-STOKES EQUATIONS ON UNSTRUCTURED ADAPTIVE GRIDS WITH AN IMPLICIT ACCELERATION PROCEDURE

Delanaye, M., Liege Univ., Belgium; Geuzaine, Ph., Liege Univ., Belgium; Essers, J. A., Liege Univ., Belgium; Rogiest, P., Liege Univ., Belgium; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 18p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this paper, recent advances in the development of a new quadratic reconstruction finite-volume scheme for unstructured polygonal meshes are presented. The scheme is used to discretize the two-dimensional compressible Euler and full Navier-Stokes equations. The quadratic reconstruction is shown to lead to a full second-order accurate discretization of the advective derivatives. The accuracy of the scheme is very weakly dependent on grid distortions, a property which is very attractive for adaptive unstructured grids computations. The pseudo-time integration of the equations is performed by an implicit scheme based on Newton-Krylov techniques. The linear system that arises from the Newton linearization is solved by the GMRES algorithm. The incomplete LU factorization is employed for the system preconditioning. The accuracy, efficiency and robustness of the method are demonstrated on various classical test cases respectively corresponding to inviscid and viscous laminar flows.

Author

Computational Grids; Algorithms; Unstructured Grids (Mathematics); Navier-Stokes Equation; Finite Volume Method; Laminar Flow; Computational Fluid Dynamics

19960053177 Office National d'Etudes et de Recherches Aerospatiales, Toulouse, France

A SECOND ORDER KINEMATIC SCHEME PRESERVING THE POSITIVES OF EULER COMPRESSIBLE EQUATIONS FOR FLOWS OF NON-AUTO-ADAPTIVE STRUCTURES *UN SCHEMA CINETIQUE D'ORDRE 2 PRESERVANT LES POSITIVES POUR LES EQUATION D'EULER COMPRESSIBLES SUR MAILLAGES NON STRUCTURES AUTO-ADAPTATIFS*

Villedieu, Ph., Office National d'Etudes et de Recherches Aerospatiales, France; Estivalezes, J. L., Office National d'Etudes et de Recherches Aerospatiales, France; Hylkema, J. J., Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1996; 14p; In French; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The aim of this contribution is to present the first numerical results that we have obtained with a new second order kinetic theory based scheme. The main interest of our approach is that density and internal energy can be proved to remain non negative under a CFL like condition. It is well known that classical approximate Riemann solvers, even first order accurate, do not satisfy this property. Our first order scheme is the classical kinetic scheme, based on the Maxwellian velocity distribution. Our second order extension consists of adding to the first order numerical flux anti-diffusive correction which has to be limited such that the constrains of positivity will be satisfied. It can be seen as a variant of the so-called corrected anti-diffusive flux approach. We have performed numerical computations for various two and three dimensional test cases on unstructured and self-adaptive meshes, in order to evaluate the accuracy and the robustness of this new method. Comparisons have been done with a second order extension of Roe's scheme.

Author

Maxwell-Boltzmann Density Function; Robustness (Mathematics); Unstructured Grids (Mathematics); Velocity Distribution; Computational Fluid Dynamics; Internal Energy; Kinetic Theory

19960053178 International Centre for Numerical Methods in Engineering, Barcelona, Spain

A MESHLESS TECHNIQUE FOR COMPUTER ANALYSIS OF HIGH SPEED FLOWS

Fischer, T., International Centre for Numerical Methods in Engineering, Spain; Onate, E., International Centre for Numerical Methods in Engineering, Spain; Idelsohn, S., International Centre for Numerical Methods in Engineering, Spain; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes the results of research carried out by the authors in the computer modelling of flow problems using an approximation based on 'clouds of points' which does not require the definition of a mesh. The so-called finite point method (FPM) is presented showing some examples for the solution of the one-dimensional convection diffusion equation and two dimensional compressible inviscid flows.

Author

Computerized Simulation; Approximation; Computational Fluid Dynamics; Finite Element Method; Grid Generation (Mathematics); Computational Grids

19960053179 Moscow Inst. of Aviation Technology, USSR

NUMERICAL SIMULATION OF INTERNAL AND EXTERNAL GAS DYNAMIC FLOWS ON STRUCTURED AND UNSTRUCTURED ADAPTIVE GRIDS

Pirumov, U. G., Moscow Inst. of Aviation Technology, USSR; Ivanov, I. E., Moscow Inst. of Aviation Technology, USSR; Kryukov, I. A., Moscow Inst. of Aviation Technology, USSR; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Solution algorithms for solving unsteady two dimensional Euler equations are presented. Cell centered upwind volume schemes are developed which utilize the two dimensional monotone linear reconstruction procedures. A new adaptive grid procedure is proposed to cluster the grid points in regions where they are most needed. This

procedure is generalized for unstructured grids. Numerical results in two dimensional cases are presented for linear and nonlinear convection problems.
Author
Algorithms; Computational Fluid Dynamics; Euler Equations of Motion; Convective Flow; Unstructured Grids (Mathematics); Structured Grids (Mathematics); Grid Generation (Mathematics)

19960053180 Manchester Univ., Aerospace Engineering Div., United Kingdom
AN INVESTIGATION OF THE EFFECTS OF THE ARTIFICIAL DISSIPATION TERMS IN A MODERN TVD SCHEME ON THE SOLUTION OF A VISCOUS FLOW PROBLEM
Briggs, R. D., Manchester Univ., UK; Shahpar, S., Manchester Univ., UK; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this work a total variation diminishing (TVD) artificial dissipation switching method similar to a matrix dissipation technique was studied. The switch is controlled by two parameters, the choice of flux limiter, and the value of the entropy correction parameter, which has an indirect effect. In order to study the effects of these terms we have considered a complex viscous flow problem, as further irregularities caused by artificial dissipation may present themselves in such a problem. An underexpanded jet interaction with a supersonic crossflow has been chosen. This problem includes a separated boundary layer and regions of recirculation. The effect of the artificial dissipation terms on these flow phenomena have not been examined before. The objectives of the present study were to measure the effect of the artificial dissipation switching algorithm on the accuracy of the solutions produced for this test case. Also, a quantitative and qualitative examination of the amount of real viscosity compared with the artificial viscosity being added in the solution was included.
Derived from text
Algorithms; TVD Schemes; Boundary Conditions; Computational Fluid Dynamics; Finite Volume Method

19960053181 Technische Hochschule, Inst. fuer Aerodynamik und Gasdynamik, Stuttgart, Germany
A FLUX FILTER SCHEME APPLIED TO THE EULER AND NAVIER STOKES EQUATIONS
Vinckier, A., Technische Hochschule, Germany; Jacobsen, J., Technische Hochschule, Germany; Wagner, S., Technische Hochschule, Germany; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167
Contract(s)/Grant(s): Wa424/10; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this contribution, we present a multi-dimensional upwind scheme. In contrast to the flux vector of the flux-difference-splitting method, where an upwind operator is used before the residual is calculated, this scheme uses an operator on the discrete flux integration of flux balance and then assigns filtered parts of the residuals to the vertices of a cell. The so-call flux-filter operator will be derived subsequently on a one-dimensional basis to allow a stable updating. The scheme is linearly preserving and should therefore lead to an improved accuracy. The flux-filter scheme has been successfully implemented on the Euler and thin layer Navier-Stokes equations, for structured and unstructured grids. The unstructured grids are made of triangular and quadrilateral cells.
Author
Navier-Stokes Equation; Computational Fluid Dynamics; Euler Equations of Motion; Flux Difference Splitting; Finite Difference Theory; Upwind Schemes (Mathematics)

19960053182 Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese, Belgium
IMPLICIT MULTIDIMENSIONAL UPWIND RESIDUAL DISTRIBUTION SCHEMES ON ADAPTIVE MESHES
Paillere, H., Von Karman Inst. for Fluid Dynamics, Belgium; Carette, J.-C., Von Karman Inst. for Fluid Dynamics, Belgium; Issman, E., Von Karman Inst. for Fluid Dynamics, Belgium; vanderWeide, E., Von Karman Inst. for Fluid Dynamics, Belgium; Deconinck, H., Von Karman Inst. for Fluid Dynamics, Belgium; Degrez, G., Von Karman Inst. for Fluid Dynamics, Belgium; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167
Contract(s)/Grant(s): AERO-CT-0040; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper reviews recent developments in multidimensional upwind schemes based on the residual decomposition or flux splitting approach. Unlike the standard finite volume approach, the upwind scheme is based on multidimensional physics, e.g. convection of entropy and total entropy along the streamline and convection of acoustic Riemann invariants along the Mach lines in steady supersonic flow. The resulting schemes on triangles and quadrilaterals are very compact, with stencils consisting of nearest neighbors only and can be made monotonic and second order, lie the total variation diminishing (TVD) schemes in finite volumes. Numerical examples show the improved performance compared to state-of-the-art methods. The paper further describes the introduction of convergence acceleration techniques which exploit the compactness of the stencils and the implementation of solution adaptive error control. The latter is based on scalar finite element a-posteriori error estimates which are applied to the Euler system in decoupled form thanks to the multidimensional residual decompositions.
Author
Computational Grids; Upwind Schemes (Mathematics); Finite Element Method; Supersonic Flow; TVD Schemes; Computational Fluid Dynamics; Euler Equations of Motion

19960053183 Vrije Univ., Dept. of Fluid Mechanics, Brussels, Belgium
MULTIDIMENSIONAL UPWIND DISSIPATION FOR 2D/3D EULER/NAVIER-STOKES APPLICATIONS
VanRansbeeck, P., Vrije Univ., Belgium; Hirsch, Ch., Vrije Univ., Belgium; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 14p; In English; See also 19960053167
Contract(s)/Grant(s): AERO-CT-0040/PL-2037; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Genuinely multidimensional upwind dissipation models are developed for the two- three-dimensional (2D/3D) Euler/Navier-Stokes equations using a cell-centered finite volume approach on structured grids. The numerical flux is formulated using the artificial dissipation concept. An overview is given for 2D/3D compact upwind dissipation for stencils up to 6 and 8 points respectively. A classification is set up for first and second order accurate schemes that have respectively minimum and zero cross diffusion. Second order monotone schemes are developed using the concept of non-linear limiter functions applied on multidimensional ratios of flux differences. A classification is presented for different families of 2D ratios. Three dimensional multidimensional limiters based on 3D ratios of flux differences are introduced. The scalar dissipation models are extended and applied to the Euler/Navier-Stokes equations based on a characteristic decomposition of the inviscid operator. The resulting characteristic compatibility equations consisting of convective and source terms are dependent on a set of 3 propagation directions. An overview is given for different choices of directions. The multidimensional discretization is considered for both the convective and source terms along its associated advective speed.
Author
Upwind Schemes (Mathematics); Structured Grids (Mathematics); Finite Volume Method; Navier-Stokes Equation; Euler Equations of Motion; Computational Fluid Dynamics; Flux Difference Splitting

19960053184 Technical Univ. of Istanbul, Faculty of Aeronautics and Astronautics, Turkey
A PCG/E-B-E ITERATION FOR HIGH ORDER AND FAST SOLUTION OF 3-D NAVIER-STOKES EQUATIONS
Aslan, A. Rustem, Technical Univ. of Istanbul, Turkey; Gulcat, Ulgen, Technical Univ. of Istanbul, Turkey; Misirhoglu, Aydun, Technical Univ. of Istanbul, Turkey; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167
Contract(s)/Grant(s): Proj. 494; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A second order accurate (both in time and space) explicit/implicit scheme is implemented for the solution of three-dimensional incompressible Navier-Stokes equations involving a high Reynolds number flow about complex configurations. A fourth order accurate artificial dissipation term on the momentum equations are used for stabilizing. A finite element method (FEM) with an explicit time marching scheme is used for the solution, and an element-by-element (E-B-E) technique is employed in order to ease the memory requirements needed by the

storage of the stiffness matrix of FEM. The cubic cavity problem, laminar flow past a sphere at a high Reynolds number and an incompressible viscous flow around the fuselage of a helicopter are successfully solved using the first and third order accurate schemes. A comparison of the results is also provided.
Author
High Reynolds Number; Incompressible Flow; Finite Element Method; Navier-Stokes Equation; Stiffness Matrix; Time Marching; Viscous Flow; Computational Fluid Dynamics

19960053185 Pennsylvania State Univ., Propulsion Engineering Research Center, University Park, PA United States
CONVERGENCE ACCELERATION OF THE NAVIER-STOKES EQUATIONS THROUGH TIME-DERIVATIVE PRECONDITIONING
Merkle, Charles L., Pennsylvania State Univ., USA; Venkateswaran, Sankaran, Pennsylvania State Univ., USA; Deshpande, Manish, Pennsylvania State Univ., USA; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167
Contract(s)/Grant(s): NAS8-3886; NCC8-46; NAGw-1356; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Chorin's method of artificial compressibility is extended to both compressible and incompressible fluids by using physical arguments to define artificial fluid properties that make up a local preconditioning matrix. In particular, perturbation expansions are used to provide appropriate temporal derivatives for the equations of motion at both low speeds and low Reynolds numbers. These limiting forms are then combined into a single function that smoothly merges into the physical time derivatives at high speeds so that the equations are left unchanged at transonic, high Reynolds number conditions. The effectiveness of the resulting preconditioning procedures for the Navier-Stokes equations is demonstrated for a wide speed and Reynolds number ranges by means of stability results and computational solutions. Nevertheless, the preconditioned equations sometimes fail to provide a solution for applications for which the non-preconditioned equations converge. Often this is because the reduced dissipation in the preconditioned equations results in an unsteady solution while the more dissipative non-preconditioned equations result in a steady state. Problems of this type represent a computational challenge; it is important to distinguish between non-convergence of algorithms, and the non-existence of steady state solutions.
Author
Algorithms; Compressible Fluids; Navier-Stokes Equation; Reynolds Number; Equations of Motion; Incompressible Fluids; Computational Fluid Dynamics; Time Functions

19960053186 NASA Ames Research Center, Moffett Field, CA United States
PRACTICAL ASPECTS OF KRYLOV SUBSPACE ITERATIVE METHODS IN CFD
Pulliam, Thomas H., NASA Ames Research Center, USA; Rogers, Stuart, NASA Ames Research Center, USA; Barth, Timothy, NASA Ames Research Center, USA; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Implementation issues associated with the application of Krylov subspace iterative methods, such as Newton-GMRES, are presented within the framework of practical computational fluid dynamic (CFD) applications. This paper categorizes, evaluates, and contrasts the major ingredients (function evaluations, matrix-vector products, and preconditioners) of Newton-GMRES Krylov subspace methods in terms of their effect on the local linear and global nonlinear convergence, memory requirements, and accuracy. The discussion focuses on Newton-GMRES in both a structured multi-zone incompressible Navier-Stokes solver and an unstructured mesh finite-volume Navier-Stokes solver. Approximate versus exact matrix-vector products, effective preconditioners, and other pertinent issues are addressed.
Author
Computational Fluid Dynamics; Navier-Stokes Equation; Newton Methods; Finite Volume Method; Iterative Solution; Unstructured Grids (Mathematics); Parallel Processing (Computers)

19960053187 National Aerospace Lab., Amsterdam, Netherlands
HEXAHEDRON BASED GRID ADAPTATION FOR FUTURE LARGE EDDY SIMULATION
vanderVegt, J. J. W., National Aerospace Lab., Netherlands; vanderVen, H., National Aerospace Lab., Netherlands; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper discusses a new numerical method which enables the future application of large eddy simulation to high Reynolds number aerodynamic flows. The new numerical method uses local grid refinement of hexahedral cells and the discontinuous Galerkin finite element method. This method offers maximum flexibility in grid adaptation and maintains accuracy on highly irregular grids. The method is demonstrated with calculations of inviscid transonic flow on a generic delta wing. The calculations are done on two parallel shared memory computers and the performance results are used to give estimates of the computing time and memory requirements for a large eddy simulation of a clean wing on a NEC SX-4 supercomputer.
Author
Computational Grids; Computational Fluid Dynamics; Delta Wings; Finite Element Method; Parallel Computers; Reynolds Number; Vortices

19960053188 Universiteit Twente, Dept. of Applied Mathematics, Enschede, Netherlands
PARALLEL ALGORITHMS FOR DNS OF COMPRESSIBLE FLOW
Streng, Martin, Universiteit Twente, Netherlands; Kuerten, Hans, Universiteit Twente, Netherlands; Broeze, Jan, Universiteit Twente, Netherlands; Geurts, Bernard, Universiteit Twente, Netherlands; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

We indicate that the use of higher order accurate spatial discretization is necessary to obtain sufficiently accurate direct numerical simulation (DNS) for the validation of subgrid models in large eddy simulation (LES). Furthermore, we pay attention to the efficiency of the implementation of these discretizations on several parallel platforms. In order to illustrate this, we consider compressible flow over a flat plate. We give a-priori test results for LES of this flow.
Author
Algorithms; Compressible Flow; Flat Plates; Vortices; Parallel Processing (Computers); Navier-Stokes Equation; Computational Grids

19960053189 Institut de Mecanique de Grenoble, France
A STRAIGHTFORWARD 3D MULTI-BLOCK UNSTEADY NAVIER-STOKES SOLVER FOR DIRECT AND LARGE-EDDY SIMULATIONS OF TRANSITIONAL AND TURBULENT COMPRESSIBLE FLOWS
Comte, P., Institut de Mecanique de Grenoble, France; Silvestrini, J. H., Institut de Mecanique de Grenoble, France; Lamballais, E., Institut de Mecanique de Grenoble, France; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 8p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A versatile and effective numerical code for direct and large eddy simulations of compressible flows is described. It is based on robust explicit finite difference methods which are second-order accurate in time and fourth-order accurate in space. An industrial application is presented with comparison to a more fundamental case, tackled with spectral and compact schemes.
Author
Finite Difference Theory; Navier-Stokes Equation; Turbulent Flow; Vortices; Computational Fluid Dynamics; Compressible Flow

19960053190 Princeton Univ., Fluid Dynamics Research Center, NJ United States
APPLICATIONS OF LATTICE BOLTZMANN METHODS TO FLUID DYNAMICS
Orszag, S. A., Princeton Univ., USA; Qian, Y. H., Columbia Univ., USA; Succi, S., IBM Italia, Italy; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In this paper, we present recent developments in the theory and application of lattice Boltzmann techniques and related lattice Bahat-

nagar-Grass-Krook (BGK) models. Lattice based methods allow the study of complicated systems with simple, efficiently computable physical models. Here we report some progress with these methods and give an overview of their basic ingredients. Applications to various types of turbulent flows are described.
Author
Computational Fluid Dynamics; Boltzmann Transport Equation; BGK Model; Lattice Parameters; Turbulent Flow; Convective Flow

19960053191 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
TRANSITION IN THE CASE OF LOW FREE STREAM TURBULENCE
Grinchenko, V. T., Academy of Sciences of the Ukraine, Ukraine; Chelyshkov, V. S., Academy of Sciences of the Ukraine, Ukraine; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A new mathematical model based on Navier-Stokes equations has been developed. The model is effective for quantitative description of a class of weakly non-homogeneous flows. The model was tested by considering a flow stability problem near a flat plate.
Derived from text
Flat Plates; Flow Stability; Navier-Stokes Equation; Turbulent Flow; Computational Fluid Dynamics; Boundary Layer Transition

19960053192 Deutsche Airbus G.m.b.H., Bremen, Germany
STRUCTURED ADAPTIVE SUB-BLOCK REFINEMENT FOR 3D FLOWS
Becker, K., Deutsche Airbus G.m.b.H., Germany; Rill, S., Technische Hochschule, Germany; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Structured sub-block refinement is a means to define a mesh at certain areas with the flow region, in order to enhance the local resolution of the flow equations or flow solution with going to costly global mesh refinement. by the use of appropriate sensors, the regions of refinement can be defined during the running flow solving process so that the adaptation becomes automatic. and the use of structured refinement, i.e., refinement by blocking areas, does only require minor changes to the overall multi-grid iteration scheme. Strategies for the selection of sub-blocks and first results for 2D and 3D Euler- and Navier-Stokes test cases are given. The drawbacks and potential of the method are described.
Author
Flow Equations; Grid Generation (Mathematics); Iterative Solution; Navier-Stokes Equation; Euler Equations of Motion

19960053193 Aermacchi S.p.A., Dipt. di Aerodinamica, Venegono Superiore, Italy
MULTIBLOCK STRUCTURED GRID ALGORITHMS FOR EULER SOLVERS IN A PARALLEL COMPUTING FRAMEWORK
Sibilla, Stefano, Aermacchi S.p.A., Italy; Vitaletti, Marcello, IBM Italia, Italy; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Specific algorithms have been developed for numerical solution of Euler equations or multi-block structured grids of general topology; these algorithms involve determination of convective and dissipative fluxes, residual collection from fine grid levels during multigrid cycles and time step evaluation. They must be properly integrated with residual and flow variable averaging when the internal boundary condition is introduced. The influence of block subdivision on the bow-shock in front of a blunt-nosed body is analyzed with different multi-block algorithms: a structured and a locally unstructured topology are also compared. Results show that no additional error is introduced in multiblock solutions if internal block boundary conditions are applied at each stage and edge/corner boundary cell contributions to flow quantities are properly taken into account.
Author
Algorithms; Parallel Processing (Computers); Structured Grids (Mathematics); Euler Equations of Motion; Boundary Conditions; Multiblock Grids; Computational Fluid Dynamics

19960053194 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
RECENT AMELIORATIONS OF THE CODE FLU3M FOR CALCULATING COMPRESSIBLE FLOWS *AMELIORATIONS RECENTES DU CODE DE CALCUL D'ECOULEMENTS COMPRESSIBLES FLU3M*
Cambier, L., Office National d'Etudes et de Recherches Aerospatiales, France; Darracq, D., Office National d'Etudes et de Recherches Aerospatiales, France; Gazaix, M., Office National d'Etudes et de Recherches Aerospatiales, France; Guillen, Ph., Office National d'Etudes et de Recherches Aerospatiales, France; Jouet, Ch., Office National d'Etudes et de Recherches Aerospatiales, France; LeToullec, L., Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1996; 10p; In French; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

We present three developments which have been introduced in the code FLU3M. A numerical method for solving the unsteady Euler equations with time-varying rigid grids is first studied; it uses the van Leer scheme together with a second order in time implicit algorithm. A bi-dimensional nozzle and an afterbody shape have been calculated with the Jones-Launder k-epsilon model, the implementation of which in the code is described for one and two species gases. Then a new implicit algorithm is shown; the DDLU factorization enables a reduction both in central processing unit (CPU) time and in memory requirements against the ADI factorization.
Author
Algorithms; Euler Equations of Motion; K-Epsilon Turbulence Model; Computational Fluid Dynamics; Time Functions

19960053196 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Design Aerodynamics, Brunswick, Germany
SOLUTION OF THE EULER- AND NAVIER-STOKES EQUATIONS ON HYBRID GRIDS
Galle, Martin, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A three dimensional finite volume scheme is presented based on the use of hybrid grids, containing tetrahedral as well as prismatic cells. The application of hybrid grids offers the possibility to combine the flexibility of tetrahedral meshes with the accuracy of regular grids. An algorithm to compute an auxiliary grid of control volumes for the entire computational domain was formulated. The dual mesh technique guarantees conservation in the entire flow field even at interfaces between prismatic and tetrahedral domains and enables the employment of an accurate upwind flow solver. Convergence to the steady state can be accelerated by a multigrid algorithm based on the agglomeration of control volumes. The formulation of such an algorithm is presented.
Author
Computational Fluid Dynamics; Computational Grids; Algorithms; Finite Volume Method; Navier-Stokes Equation; Transonic Flow

19960053197 Aerospatiale, Espace und Defense, Les Mureaux, France
SIMULATION OF THE RELATIVE MOTION OF ROCKET STAGES FOR NONSTATIONARY FLOW BY A METHOD OF OVERLAPPING GRIDS *SIMULATION DU MOUVEMENT RELATIF DE CORPS SOUMIS A UN ECOULEMENT INSTATIONNAIRE PAR UNE METHODE DE CHEVAUCHEMENT DE MAILLAGES*
Brenner, P., Aerospatiale, France; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In French; See also 19960053167; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A computational method for the simulation of rocket stages separations under aerodynamic and propulsive loads is presented. to simulate the motion of bodies, a conservative overlapping grid technique is used. The flow solver is based on a cell centered finite volume formulation on unstructured grids (made of tetrahedra, prisms, and hexaedra). The Euler equations with mixing gases are solved through a second order upwind scheme using the Godunov algorithm to compute the numerical fluxes. to integrate equations in time, a temporal adaptive algorithm is used since the real duration of the simu-

lated phenomena is long. It saves computer time and leads to accurate simulation of unsteady phenomena like acoustic waves and shocks displacements.
Author
Aerodynamic Loads; Finite Volume Method; Unstructured Grids (Mathematics); Upwind Schemes (Mathematics); Computational Fluid Dynamics

19960053198 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Design Aerodynamics, Brunswick, Germany
EFFICIENT NUMERICAL SIMULATION OF COMPLEX 3D FLOWS WITH LARGE CONTRAST
Radespiel, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Longo, J. M. A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Brueck, S., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Schwamborn, D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Recent progress in flux vector splitting is reviewed with the aim to obtain high resolution and robustness for hypersonic reacting flow simulations. The numerical behavior of promising AUSM and CUSP discretization variants is reported and compared. These schemes can be combined with explicit multistage time stepping and multigrid. Large chemical source terms introduce stiffness into the system of equations which is removed by point implicit treatment. The results demonstrate that efficient 3D simulation of viscous reacting flows with large contrast generated by strong shocks are now feasible.
Author
Flux Vector Splitting; Robustness (Mathematics); Viscous Flow; Hypersonic Flow; Reacting Flow; Computational Fluid Dynamics; Multigrid Methods

19960053199 Centre National de la Recherche Scientifique, Lab. d'Analyse Numerique, Paris, France
HYBRID UPWIND SPLITTING METHODS FOR THE SIMULATION OF THERMAL AND CHEMICAL NONEQUILIBRIUM FLOWS *METHODES DE DECENTREMENT HYBRIDES POUR LA SIMULATION D'ECOULEMENTS EN DESEQUILIBRE THERMIQUE ET CHIMIQUE*
Coquel, Frederic, Centre National de la Recherche Scientifique, France; Joly, Veronique, Office National d'Etudes et de Recherches Aerospatiales, France; Marmignon, Claude, Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1996; 12p; In French; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents a hybrid upwind splitting method fully adapted to viscous chemical and thermal nonequilibrium flows. Such flows are the site of strong viscous-inviscid interactions and are dominated by real gas effects due to dissociation and internal mode excitation. Furthermore, the hyper-velocities along the reentry trajectory induce a larger degree of thermo-chemical non-equilibrium. ONERA has developed a code for simulating such flows: the code CELHYO. Detailed works concerning the physical modeling having already been presented in previous papers, the emphasis here is on the numerical method, and particularly on the extension of hybrid upwind splitting methods to non-equilibrium flows. The hybrid upwinding is achieved by combining the basically distinct flux vector and flux difference splitting approaches in retaining their own interesting features. The hybrid method implemented in the code CELHYO has been obtained by hybridizing the Osher approach with the van Leer scheme. In order to illustrate the numerical methods, internal and external flow configurations are presented.
Author
Computational Fluid Dynamics; Flux Vector Splitting; Flux Difference Splitting; Nonequilibrium Flow; Computerized Simulation; Upwind Schemes (Mathematics)

19960053200 National Technical Univ., Lab. of Aerodynamics, Athens, Greece
A PROJECTION METHODOLOGY FOR THE SIMULATION OF UNSTEADY INCOMPRESSIBLE VISCOUS FLOWS USING THE APPROXIMATE FACTORIZATION TECHNIQUE
Pentaris, A., National Technical Univ., Greece; Tsangaris, S., National Technical Univ., Greece; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 14p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this paper, an implicit projection methodology for the solution of the two-dimensional, time dependent, incompressible Navier-Stokes equations is presented. The basic principle of this method is that the evaluation of the time evolution is split into intermediate steps. The computational method is based on the approximate factorization technique. The coupled approach is used to link the equations of motion and the turbulence model equations. The standard k-epsilon turbulence model is used. The current methodology, which has been tested extensively for steady problems, is now applied for the numerical simulation of unsteady flows. Several cases were tested, such as plane or axisymmetric channels, a backward facing step, and a flow behind a square cylinder.
Author
Backward Facing Steps; Navier-Stokes Equation; Time Dependence; Incompressible Flow; K-Epsilon Turbulence Model; Computational Fluid Dynamics

19960053201 Bristol Univ., Dept. of Aerospace Engineering, United Kingdom
ADAPTION BY GRID MOTION FOR UNSTEADY EULER AEROFOIL FLOWS
Allen, C. B., Bristol Univ., UK; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A solution-adaptive structured grid technique is described for the computation of steady and unsteady Euler flows past airfoils. Transfinite interpolation is used to generate the grids as this is well-suited to unsteady flows, since grid speeds required in the flux terms are available directly from the algebraic mapping. A novel approach to grid adaptation is described. Adaptation is performed by adapting the interpolation parameters, instead of the physical grid positions, so the adapted grid positions are available algebraically. Hence, the grid speeds required for unsteady computations are also available algebraically. For unsteady flows grid adaptation is performed by imposing an 'adaptation velocity' on grid points, thereby applying the adaptation gradually over several time steps and avoiding the interpolation of the solution from one grid to another, associated with instantaneous adaptation. Steady and unsteady airfoil flows are considered. In both cases the adaptive grid technique is shown to produce sharper shock resolution for a very small increase in central processing unit (CPU) requirements.
Author
Computational Fluid Dynamics; Computational Grids; Unsteady Flow; Steady Flow; Euler Equations of Motion; Time Dependence; Airfoils

19960053202 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Stroemungsmechanik, Goettingen, Germany
ADAPTIVE COMPUTATION OF UNSTEADY FLOW FIELDS WITH THE DLR-TAU-CODE
Friedrich, O., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Hempel, D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Meister, A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Sonar, Th., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 12p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The features and abilities of the DLR-tau-code, a finite volume approximation of box type for the Navier-Stokes equations governing viscous, compressible fluid flow, are described in detail. The code is able to compute flow in moving reference frames and is built upon dynamic adaptive concepts to allow for grid refinement in the frame-

work of non-stationary aerodynamics. Implicit as well as explicitly time-stepping schemes can be used depending on the kind of application.
Author
Navier-Stokes Equation; Computational Grids; Finite Volume Method; Computational Fluid Dynamics; Time Functions; Compressible Fluids

19960053203 Instituto Nacional de Tecnica Aeroespacial, Esteban Terradas, Aerodynamics Div., Torrejon de Ardoz, Spain
PARAMETRIC STUDIES OF A TIME-ACCURATE FINITE-VOLUME EULER CODE IN THE NWT PARALLEL COMPUTER
Ruiz-Calavera, L. P., Instituto Nacional de Tecnica Aeroespacial, Esteban Terradas, Spain; Hirose, N., National Aeronautical Lab., Japan; Progress and Challenges in CFD Methods and Algorithms; Apr. 1996; 10p; In English; See also 19960053167; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A code to calculate unsteady aerodynamic loads on non-uniformly moving 3D isolated wings has been prepared. The Euler equations are solved by means of a time-accurate finite volume method with second order central spatial discretization and Runge-Kutta time integration. The code has been implemented in a parallel supercomputer. The numerical scheme used together with some representative results are presented.
Author
Aerodynamic Loads; Euler Equations of Motion; Finite Volume Method; Runge-Kutta Method; Parallel Computers; Unsteady Aerodynamics; Parallel Processing (Computers)

19970009251 Calspan-Buffalo Univ. Research Center, Physics and Chemistry Sciences Dept., NY United States
VISCOUS/INVISCID AND REAL-GAS EFFECTS ASSOCIATED WITH HYPERSONIC VEHICLES
Holden, Michael S., Calspan-Buffalo Univ. Research Center, USA; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 82p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A05, Hardcopy; A04, Microfiche

In this segment of the lecture series, we discussed some of the important effects of viscous/inviscid interaction and real gas phenomena on the design and performance of hypersonic vehicles. Following a general review of the importance of such effects on vehicle design and performance, we discuss the effects of non-equilibrium and real-gas flows with emphasis on their importance to the accurate simulation of hypervelocity flows in ground test facilities. Because boundary layer transition exerts a dominant influence on vehicle performance in a hypersonic flow regime, we briefly review some of the key phenomena which control boundary layer transition in regions of adverse pressure gradient crossflow and along the attachment line of swept leading edges. For it is such phenomena, where it is currently believed that experimental measurements in hypersonic ground test facilities are of relevance. The key phenomena associated with shock-wave/boundary layer interaction for both laminar and turbulent, two- and three-dimensional flows are briefly reviewed and compared with the most recent prediction techniques. The aerothermal loads and flowfield phenomena associated with regions of shock/shock interaction are then discussed with particular emphasis on the effects of boundary layer transition and low-density flows on the magnitude of the peak heating in regions of Type 3 and 4 interactions. Film and transpiration cooling must be employed to cool the internal components of high performance scramjet engines. Correlations are presented to show the effectiveness and relative effectiveness of film and transpiration cooling both with and in the absence of shockwave/boundary layer interaction. The aerothermal and aero-optical performance of seeker-heads for hypersonic interceptors represents currently one of the most key areas in hypersonic technology. The techniques that are being employed to obtain measurements of the aerothermal and aero-optical performance in the LENS facility are briefly reviewed. Finally, we present information on the 'CUBDAT' database of hypersonic measurements which have been assembled from fundamental studies of the phenomena discussed in this segment of the lecture series.
Author
Viscous Flow; Inviscid Flow; Real Gases; Hypersonic Flow; Hypersonics; Gas Flow; Boundary Layer Transition; Film Cooling; Shock Wave Interaction; Aerothermodynamics

19970009257 NASA Lewis Research Center, Cleveland, OH United States
ADVANCED COMPUTATIONAL TECHNIQUES FOR HYPERSONIC PROPULSION
Povinelli, Louis A., NASA Lewis Research Center, USA; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 18p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

CFD has played a major role in the resurgence of hypersonic flight, on the premise that numerical methods will allow us to perform simulations at conditions for which no ground test capability exists. Validation of CFD methods is being established using the experimental data base available, which is below Mach 8. It is important, however, to realize the limitations involved in the extrapolation process as well as the deficiencies that exist in numerical methods at the present time. Current features of CFD codes are examined for application to propulsion system components. The shortcomings in simulation and modeling are identified and discussed.
Author
Computational Fluid Dynamics; Hypersonic Flow; Propulsion System Performance; Inlet Flow; Reacting Flow; Mach Number

19970021641 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
TURBULENCE IN COMPRESSIBLE FLOWS *LA TURBULENCE DANS LES ECOULEMENTS COMPRESSIBLES*
Turbulence in Compressible Flows; Jun. 1997; 308p; In English, 2-6 Jun. 1997, Rhode-Saint-Genese, Newport News, VA, Belgium, USA; Sponsored by NASA Langley Research Center, USA; See also 19970021642 through 19970021647
Report No.(s): AGARD-R-819; ISBN 92-836-1057-1; Copyright Waived; Avail: CASI; A14, Hardcopy; A03, Microfiche

Lecture notes for the AGARD Fluid Dynamics Panel (FDP) Special Course on 'Turbulence in Compressible Flows' have been assembled in this report. The following topics were covered: Compressible Turbulent Boundary Layers, Compressible Turbulent Free Shear Layers, Turbulent Combustion, DNS/LES and RANS Simulations of Compressible Turbulent Flows, and Case Studies of Applications of Turbulence Models in Aerospace.
Author
Compressible Flow; Computational Fluid Dynamics; Turbulent Flow; Turbulent Boundary Layer; Turbulent Combustion; Lectures; Laminar Flow; Transition Flow; Turbulence

19970021642 Princeton Univ., Dept. of Mechanical and Aerospace Engineering, NJ United States
COMPRESSIBLE TURBULENT BOUNDARY LAYERS
Smits, A. J., Princeton Univ., USA; Turbulence in Compressible Flows; Jun. 1997, 1.1-1.58; In English; See also 19970021641
Contract(s)/Grant(s): F49620-89-I-0420; F49620-90-I-0217; F49620-93-I-0476; F49620-93-I-0064; F49620-93-I-0427; F49620-93-I-0478; Copyright Waived; Avail: CASI; A04, Hardcopy; A03, Microfiche

These notes review what is currently known about the structure of zero-pressure-gradient, flat-plate turbulent boundary layers. The behavior of boundary layers in subsonic and supersonic flows is discussed, with a particular emphasis on scaling laws with respect to Reynolds number and Mach number.
Author
Turbulent Boundary Layer; Compressible Flow; Reynolds Number; Subsonic Flow; Supersonic Flow; Flat Plates; Mach Number; Boundary Layer Equations; Scaling Laws

19970021643 Illinois Univ., Dept. of Mechanical and Industrial Engineering, Urbana-Champaign, IL United States
COMPRESSIBLE TURBULENT FREE SHEAR LAYERS
Dutton, J. Craig, Illinois Univ., USA; Turbulence in Compressible Flows; Jun. 1997, 2.1-2.42; In English; See also 19970021641; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Recent experimental work in the area of compressible turbulent free shear layers is reviewed. Results for the canonical two-stream, constant-pressure shear layer are given. Emphasis is placed on growth rate, turbulence statistical quantities, large-scale turbulent structure, and growth rate enhancement. Compressible free shear layers present in high-speed separated flows are also considered. Here, results on mean flow, turbulence statistics, and large turbulent structures are discussed. Additional effects in these separated flows,

such as the expansion that may occur at separation and the bulk compression, streamline curvature, and lateral streamline convergence that may occur at reattachment, are discussed. In order to develop a sound physical understanding of these compressible turbulent flows, particular attention is given to single-frame and multiframe planar imaging studies.
Author
Separated Flow; Shear Layers; Turbulent Flow; Supersonic Flow; Gas Flow; Incompressible Flow; Compressibility Effects; Combustion; Turbulence

19970021645 Institut de Mecanique de Grenoble, LEGI, France
LARGE-EDDY SIMULATIONS OF COMPRESSIBLE TURBULENT FLOWS
Lesieur, M., Institut de Mecanique de Grenoble, France; Comte, P., Institut de Mecanique de Grenoble, France; Turbulence in Compressible Flows; Jun. 1997, 4.1-4.39; In English; See also 19970021641; Sponsored in part by Institut Universitaire de France
Contract(s)/Grant(s): ONERA-22.492/DA/A1.CC1; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In the first lecture, we describe the general framework of large-eddy simulations (LES) applied to incompressible flows, with Smagorinsky's model. Afterwards we concentrate on LES from a spectral-space point of view. We introduce Kraichnan's spectral eddy-viscosity, and how it can be handled for LES purposes in isotropic turbulence, in terms of the plateau-cusp model. We generalize the spectral eddy viscosity to a spectral eddy diffusivity. Using the nonlocal interaction theory, we discuss the backscatter issue, and present a generalization of spectral eddy coefficients allowing to account for non-developed turbulence in the subgrid scales, the spectral-dynamic model. Applications of this model to a channel flow will be given, with comparisons with DNS, experiments, and the classical dynamic model. The latter will be presented and discussed. The second lecture will be devoted to the action of compressibility upon free-shear and separated flows. We will work in physical space. We will first present the structure-function model (SSF), the filtered SSF, and the selective SSF, as well as a version of the spectral-dynamic model in physical space, in terms of a combination of the structure-function model and a hyperviscosity. Afterwards, we will justify the use of an essentially incompressible subgrid-modelling for LES of compressible turbulence. Then, we will look at the effects of compressibility upon coherent vortices in mixing layers, and see in particular how helical pairing is inhibited above a convective Mach number of 0.7. We will consider also a round jet, and finally a separated flow in a configuration related to ARIANE V solid-propergol boosters. In the third lecture, we will concentrate on LES of compressible boundary layers. First, we will look at a weakly compressible boundary layer (M(infinity) = 0.5) spatially developing upon an adiabatic flat plate. Afterwards, we will consider a temporal boundary layer at Mach 4.5, and show how LES allow to describe the whole process of transition to turbulence. Finally, the structure of turbulence in the neighborhood of HERMES space shuttle's rear flap at Mach 2.5 will be examined.
Author
Turbulent Flow; Supersonic Speed; Separated Flow; Turbulence; Eddy Viscosity; Turbulence Models; Channel Flow; Compressibility; Shear Flow; Compressible Flow; Computerized Simulation; Computational Fluid Dynamics

19970021646 Rutgers Univ., Dept. of Mechanical and Aerospace Engineering, Piscataway, NJ United States
NUMERICAL SIMULATION OF COMPRESSIBLE TURBULENT FLOWS USING THE REYNOLDS-AVERAGED NAVIER-STOKES EQUATIONS
Knight, Doyle D., Rutgers Univ., USA; Turbulence in Compressible Flows; Jun. 1997, 5.1-5.52; In English; See also 19970021641
Contract(s)/Grant(s): F49620-96-I-0389; Copyright Waived; Avail: CASI; A04, Hardcopy; A03, Microfiche

The paper assesses the capability for numerical simulation of compressible turbulent flows using the Reynolds-averaged Navier-Stokes equations. The governing Favre-averaged equations are derived, and the various levels of turbulence models defined. Examples of zero, one-equation, two-equation and Reynolds Stress Equation turbulence models are presented. Specific results are discussed for boundary layer and free shear flows. Conclusions regarding future work are presented.
Author
Computational Fluid Dynamics; Navier-Stokes Equation; Reynolds Equation; Turbulent Flow; Compressible Flow; Free Flow; Reynolds Stress; Flow Characteristics; Computerized Simulation; Shear Flow

19970021647 Daimler-Benz Aerospace A.G., Munich, Germany
CASE STUDIES OF APPLICATIONS OF TURBULENCE MODELS IN AEROSPACE
Haase, W., Daimler-Benz Aerospace A.G., Germany; Turbulence in Compressible Flows; Jun. 1997, 6.1-6.30; In English; See also 19970021641; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Validation of CFD methods is an ongoing process and it strongly depends on an assessment of flow-physics models employed in this process. On the basis of reliable numerical methods whether they are of boundary layer type or thin-layer or full Navier-Stokes approaches, predictive capabilities of turbulence models have to be validated in order to achieve accurate answers on the simulation of complex flow phenomena. Results are presented and discussed for two-dimensional and three dimensional flow cases and for a variety of turbulence models that are nowadays in use in the field of aeronautics and, more specifically, in the aeronautics industry. Moreover, some aspects of transition region modeling, hence enabling in general a continuous growth of turbulence - in contrast to merely 'switching on' the desired eddy-viscosity turbulence model 'abruptly' - are discussed. Additionally, attention is paid on problems related to accuracy and efficiency of a proper validation of turbulence models and numerical methods.
Author
Computational Fluid Dynamics; Three Dimensional Flow; Two Dimensional Flow; Turbulence Models; Navier-Stokes Equation; Flow Characteristics; Aerospace Engineering; Turbulent Flow; Turbulent Boundary Layer

19970025584 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
SONIC NOZZLES FOR MASS FLOW MEASUREMENT AND REFERENCE NOZZLES FOR THRUST VERIFICATION
Jun. 1997; 86p; In English
Report No.(s): AGARD-AR-321; ISBN 92-836-1056-3; Copyright Waived; Avail: CASI; A05, Hardcopy; A01, Microfiche

This report presents the results of a multinational effort to reflect the state-of-the-art for the accurate measurement of massflow and thrust. The accurate measurements of these quantities is essential to the success of windtunnel tests supporting engine-airframe aerodynamic integration studies. It is concluded that the measurement of gaseous mass flows with +/-0.1% or better is still very difficult. For most test cases, however, with reasonable care, bias and random errors can be kept within +/-0.1% respectively. For thrust measurements, these values must typically be doubled. This report presents the results of work conducted by Working Group 19 of the AGARD Fluid Dynamics Panel.
Author
Aerodynamic Characteristics; Mass Flow; Flow Measurement; Thrust Measurement; Sonic Nozzles; Fluid Dynamics; Gas Analysis

19970026368 Fluid Gravity Engineering Ltd., Liphook, United Kingdom
HEAT TRANSFER FOR PERFECT GAS AND CHEMICALLY REACTING FLOWS
Smith, Arthur, Fluid Gravity Engineering Ltd., UK; May 1995; 14p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In this section we focus on basic principles and the derivation of some basic relationships used in heat transfer analysis for planetary entry. Catalytic mechanisms and their effect on the thermal protection system is considered, finally radiation transport and regimes are briefly examined.
Author
Reacting Flow; Atmospheric Entry; Ideal Gas; Thermal Protection; Aerodynamic Heating; Heat Transfer; Radiation Transport; Aerothermodynamics

19970026376 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
ABLATION
Devezeaux, D., Office National d'Etudes et de Recherches Aerospatiales, France; Hollanders, H., Aerospatiale, France; May 1995; 10p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

When a vehicle is entering atmosphere at very large speeds, typically more than 4000 m/s, the mixture of gas which surrounds the body is heated by compression mechanisms at its front, and by friction inside the boundary layer. The temperature gradients are strong enough to induce some large energy transferred through the wall. One has to characterize the stiffness of this environment by the heat flux, an hypothetic wall at arbitrary temperature will receive, when isolated from the surrounding flowfield. This heat flux is depending on the velocity, altitude, shape geometry, and local point to be considered. For a ballistic re-entry body, which has a drag force quite small with respect to its weight, large velocity values are achieved until low altitude where density is rather high. The heat fluxes could reach values up to several hundred of MW/sq m, for an isolated wall. None material can resist to such heating. So, it needs the use of ablative materials, which disappear by means of physico-chemical processes with air.
Author
Ablation; Reentry Vehicles; Atmospheric Entry; Thermal Protection; Ablative Materials; Walls; Heat Flux; Aerodynamic Heating; Reentry Shielding; Spacecraft Shielding

19980020532 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
HIGH SPEED BODY MOTION IN WATER *LE MOUVEMENT DES CORPS EVOLUANT A GRANDE VITESSE DANS L'EAU*
High Speed Body Motion in Water; Feb. 1998; 352p; In English; Fluid Dynamics Panel Workshop: High Speed Body Motion in Water, 1-3 Sep. 1997, Kiev, Ukraine; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19980020533 through 19980020565; Original contains color illustrations
Report No.(s): AGARD-R-827; ISBN 92-836-1071-7; Copyright Waived; Avail: CASI; A16, Hardcopy; A03, Microfiche

This report is a compilation of the edited proceedings of a Workshop on "High Speed Body Motion in Water" held at the National Academy of Sciences in Kiev, Ukraine, 1-3 September 1997. Technical topics covered during the workshop included Hydrobionics, Boundary Layer Flows, Supercavitating Flows, Air-water Penetration and Control of Cavitation.
Author
Boundary Layer Flow; Conferences; Supercavitating Flow; Hydrodynamics; Hydromechanics; Underwater Propulsion; Air Water Interactions

19980020533 Naval Undersea Warfare Center, Weapons Technology and Tactical Vehicle Systems Dept., Newport, RI United States
THE SWIMMING HYDRODYNAMICS OF A PAIR OF FLAPPING FOILS ATTACHED TO A RIGID BODY
Bandyopadhyay, Promode R., Naval Undersea Warfare Center, USA; Donnelly, Martin J., Virginia Polytechnic Inst. and State Univ., USA; High Speed Body Motion in Water; Feb. 1998; 17p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

Inspired by the natural action of flapping in aquatic locomotion, a dual flapping foil device was developed. The performance of the device in providing propulsive and maneuvering forces to small rigid axisymmetric bodies will be detailed. Two modes of flapping were investigated: waving and clapping. The clapping motion of wings is a common mechanism for the production of lift and thrust in the insect world, particularly in butterflies and moths. Waving is similar to the motion of the caudal fin of a fish. A model was built (1 m long, 7.6 cm diameter) with flapping foils at the end of the tail cone and various measurements were performed in a water tunnel. (In hindsight, the model can be described as a rigid bodied mechanical seal because seals have remarkably similar dual flaps in their tails.) Time-dependent tests of thrust, drag, and yawing moment were conducted for several flapping frequencies commonly observed in relevant aquatic animals. Phase-matched laser Doppler anemometry measurements of the near wake were carried out and detailed vorticity-velocity vector maps of the vortex shedding process have been obtained for the axial and cross-stream planes. Dye visualization of wake was documented and a video recording was prepared of the entire dynamic process. The ability of the dual flapping foil device to produce a net thrust and maneuvering cross-stream forces has been demonstrated, although the main body is rigid. Its wake, which is composed of jets, is extremely wide, nonrotating, and rapidly decaying. The thrust production greatly increases with Strouhal number. The results have been compared with two dimensional inviscid flapping foil theories and measurements. The effect of the rigid cylinder on the flapping performance is extracted. The efficiency of thrust production generally increases in the waving mode which mimics the side-to-side head motion of a fish. Efficiency also tends to peak roughly in the Strouhal number range popular among fish. Axial thrust shows sensitivity to Strouhal number in the range popular among fish. However, existing non-linear inviscid theories do not capture this aspect and the strong viscous effects observed also need to be included.
Author
Two Dimensional Models; Axisymmetric Bodies; Hydrofoils; Water Tunnel Tests; Flapping; Computer Aided Mapping

19980020534 Institute of Theoretical and Applied Mechanics, Novosibirsk, Russia
SUBSTITUTION OF ROLLING FOR SLIPPING AS AN EFFECTIVE MECHANISM OF DECREASING HYDRODYNAMIC DRAG
Merkulov, V. I., Institute of Theoretical and Applied Mechanics, Russia; High Speed Body Motion in Water; Feb. 1998; 3p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

As is shown by theoretical and experimental research, the general mechanism of crucial reduction of hydrodynamic drag consists in substituting rolling friction for slipping friction. This mechanism is realized at a boundary layer reconstruction with formation of periodic transverse vortices that are rolling without slipping over the body surface. A small velocity gradient characterizing such a motion results in low energy dissipation. A traveling wave on an elastic body surface works as a mechanism for formation of a periodic vortex structure for some water animals, such as dolphins. At appropriate elastic parameters of the surface, the wave is excited in a regime of hydroelastic flutter. The surface roughness, as it takes place with sharks, expands the range of velocities at which traveling waves are excited, though it decreases their energy efficiency.
Author
Drag Reduction; Traveling Waves; Vortices; Fluid Flow; Flow Resistance; Boundary Layer Flow

19980020535 Academy of Sciences of the Ukraine, Dept. of Hydrobionics and Boundary Layer Control, Kiev, Ukraine
HYDROBIONICS PRINCIPLES OF DRAG REDUCTION
Babenko, V. V, Academy of Sciences of the Ukraine, Ukraine; Feb. 1998; 14p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

General principle of optimization of alive organism consists, as a result of many-centuries evolution, in attainment of minimal energy expenditures for maintaining the process of life. Principal attention in this investigation is payed to study of peculiarities of organism systems and their interaction in the process of motion of water animals, which are directed at the reduction of energy expenditures. On dolphin example, considered are peculiarities of morphology and physiology of skeleton, muscles, skin coating, blood system and innervation. As the motion takes place in the water medium, considering those systems the force influence of medium onto the organism is taken into account. Studied are influence of swimming speed, non-steadiness of flow, unusual method of thrust creation, and specific structure of body surface onto the body systems. Also considered are some peculiarities of hydrodynamic influence onto the body when moving in water medium. In accordance with these peculiarities, specific structures of mentioned systems of water animals are analyzed. Here, there are detailed descriptions of skeleton and location of innervation ganglions as well as layer-by-layer location, along diameter and body length, of moving muscles. Structure of skin coatings is given in detail especially. The peculiarities of blood system and structure of that in skin coating are analyzed. Presented are results of measurements of temperature distribution on the surface of body skin and results of theoretical estimation of controlled heat conductivity of skin. by means of apparatus developed, the measurements of distribution for elasticity and damping properties of skin of different dolphin types are carried out. Presented are results of direct and indirect measurements of other

mechanical parameters of skin, in particular phase velocity of disturbances development. The results of measurements of turbulent boundary layer in different regimes of dolphin motion are given. Described are the functioning of body systems and mechanisms for regulation of mechanical features of skin. The ways of reduction of body motion drag are shown.
Author
Dolphins; Drag Reduction; Flow Velocity; Turbulent Boundary Layer; Skin (Anatomy)

19980020536 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
TURBULENT BOUNDARY LAYER OVER A COMPLIANT SURFACE
Voropaev, G. A., Academy of Sciences of the Ukraine, Ukraine; Rozumniuk, N. V., Academy of Sciences of the Ukraine, Ukraine; High Speed Body Motion in Water; Feb. 1998; 11p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Numerical results of modeling of turbulent boundary layers over deformable viscoelastic surfaces are presented. A qualitative interpretation of friction drag reduction on a deformable surface is given. Quantitative characteristics of interaction of a turbulent boundary layer with the deformable surface at various magnitudes of parameters describing viscoelastic properties of the material are obtained.
Author
Deformation; Drag Reduction; Friction Drag; Turbulent Boundary Layer; Turbulent Flow; Mathematical Models; Viscoelasticity

19980020538 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
DISTINCTIVE FEATURES OF THE WAVE PLATE (OR FISH) MOTION
Korennaya, L. I., Academy of Sciences of the Ukraine, Ukraine; High Speed Body Motion in Water; Feb. 1998; 9p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The measurements of the thrust force of the wavelike deformable plate in three-dimensional flow were carried out on specially constructed equipment. The laws which were found out by other authors in research of water animals (fish and dolphins) were reviewed. The vortical model of the wave-like deformable plate reflects three dimensional flow space. This model was used to calculate the hydrodynamic forces and coefficients of the wave-like deformable plate (the mechanical model of wave propulsion). Our measurements, calculations, comparisons with ideal hydraulic propulsion have shown the distinctive features of the wave-like deformable plate as it creates the thrust force. The distinctive features of boundary layer formation on the wave-like deformable body are also considered. There is a boundary layer control system in nature with running waves. Concepts similar to Prandtl's about boundary layer control by means of the moving surface of the body has existed in nature for centuries.
Author
Boundary Layer Control; Hydrodynamic Coefficients; Three Dimensional Flow; Elastic Deformation; Elastic Plates; Underwater Propulsion

19980020539 Stanford Univ., Dept. of Aeronautics and Astronautics, Stanford, CA United States
A NEW VIEW OF THE DYNAMICS OF REYNOLDS STRESS GENERATION IN TURBULENT BOUNDARY LAYERS
Cantwell, Brian J., Stanford Univ., USA; Chacin, Juan M., Stanford Univ., USA; High Speed Body Motion in Water; Feb. 1998; 10p; In English; See also 19980020532
Contract(s)/Grant(s): NCC2-55; NAG1-1610; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The structure of a numerically simulated turbulent boundary layer over a flat plate at Re(theta) = 670 was studied using the invariants of the velocity gradient tensor (Q and R) and a related scalar quantity, the cubic discriminant (D = 27R(exp 2)/4 + Q(exp 3)). These invariants have previously been used to study the properties of the small-scale motions responsible for the dissipation of turbulent kinetic energy. In addition, these scalar quantities allow the local flow patterns to be unambiguously classified according to the terminology proposed by Chong et al. The use of the discriminant as a marker of coherent motions reveals complex, large-scale flow structures that are shown to be associated with the generation of Reynolds shear stress - u'v'(bar). These motions are characterized by high spatial gradients of the discriminant and are believed to be an important part of the mechanism that sustains turbulence in the near-wall region.
Author
Flat Plates; Flow Distribution; Reynolds Stress; Turbulent Flow; Turbulent Boundary Layer; Computerized Simulation

19980020540 Arizona State Univ., Mechanical and Aerospace Engineering, Tempe, AZ United States
CONTROL OF GOERTLER VORTICES
Saric, William S., Arizona State Univ., USA; Feb. 1998; 5p; In English; See also 19980020532
Contract(s)/Grant(s): F49620-96-1-0369; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

It is shown that convex curvature is a strong nonlinear stabilizer of Gortler vortices. It is also conjectured that sub-critical roughness can prevent the growth of more unstable modes and hence delay transition.
Author
Nonlinearity; Vortices; Surface Roughness Effects; Goertler Instability; Flow Distortion; Curvature

19980020541 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
EXPERIMENTAL INVESTIGATION OF THE BOUNDARY LAYER OVER RIGID AND ELASTIC PLATES
Babenko, V. V., Academy of Sciences of the Ukraine, Ukraine; High Speed Body Motion in Water; Feb. 1998; 24p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Boundary layer in natural conditions is influenced by disturbances of different types coming from outside. An approach was developed for experimental study of disturbance interaction. It was realized using a special hydrodynamic complex including a water channel with the regulated freestream turbulence level, different kinds of strain gauges and devices for the introduction of small disturbances into a boundary layer from its outer and inner edges. There were used in experiments visualization methods (in particular, tellurium method) thermo- and laser-anemometry and strain-gauging. Besides, a technique was developed to carry out measurements of space-time characteristics of disturbing motion. Kinematic, spectral and correlation characteristics were investigated at different stages of natural boundary layer transition including the turbulent state on flat and concave plates. The model of disturbance transformation through all the transition stages was proposed. Each stage was considered from the point of view of mechanisms driving the disturbance development resulting in the next stage. Some empirical relations were obtained for wave lengths of two and three-dimensional disturbances depending on the Reynolds number. Conditions of the occurrence of two transition types and their connection with two distinct intermittency factors proposed were analysed. Results were presented in the form of profiles of mean and fluctuation longitudinal velocity components and also of neutral curves and curves of maximum amplification in Tollmien-Schlichting and Goertler diagram. Structural and kinematical-dynamical principles of boundary layer interaction with compliant surfaces were formulated. Interactions of different disturbances were studied in boundary layers on resonant and dissipative compliant plates.
Author
Boundary Layer Transition; Elastic Plates; Flat Plates; Boundary Layer Flow; Vortices

19980020542 Kiev Univ., Dept. of Higher Mathematics, USSR
MODELING OF TURBULENT NEAR-WALL SHEAR FLOW PROPERTIES
Movchan, V. T., Kiev Univ., USSR; Shkvar, E. A., Kiev Univ., USSR; Feb. 1998; 7p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The given paper deals with mathematical and numerical modeling of shear flows in the vicinity of a boundary layer. The half-empirical algebraic models of turbulent viscosity and turbulent conductivity coefficients for predictions of two- and three-dimensional gradient flows on smooth and rough surfaces are proposed. These models of turbulent exchange coefficients can be effectively applied both for approximate analytical and numerical solutions of flow charac-

teristics on fixed or moving surfaces. The results of approximate analytical and numerical predictions of different kinds of boundary layers are presented.
Author
Mathematical Models; Three Dimensional Flow; Two Dimensional Flow; Flow Characteristics; Turbulence Models; Shear Flow; Boundary Layer Flow

19980020543 Louisiana Polytechnic Inst., Ruston, LA United States
DIRECT NUMERICAL SIMULATION OF TRANSITIONAL NEAR-WALL FLOW
Chelyshkov, V. S., Academy of Sciences of the Ukraine, Ukraine; Grinchenko, V. T., Academy of Sciences of the Ukraine, Ukraine; Liu, C., Louisiana Polytechnic Inst., USA; High Speed Body Motion in Water; Feb. 1998; 8p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A local approach that can be applied for investigation of near-wall flows, jets, and wakes is discussed. The approach is developed on the basis of examining the flow near a flat plate. Coupled equations, which describe both slow and fast changes of flow in longitudinal coordinates, are utilized. Possible ways of excitation of slow disturbances are studied. Direct numerical simulation (DNS) of near-wall flow is carried out. Phase speeds of propagation of 2D-disturbances are calculated.
Author
Direct Numerical Simulation; Flat Plates; Transition Flow; Wall Flow; Wall Jets; Near Wakes

19980020544 Academy of Sciences of the Ukraine, Dept. of Thermal and Hydromechanical Modeling, Kiev, Ukraine
A NEW APPROACH TO THE STUDY OF ORGANIZED VORTICAL MOTION AFFECTED BY BODY FORCES
Nikiforovich, Eugene I., Academy of Sciences of the Ukraine, Ukraine; Feb. 1998; 9p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Investigations under centrifugal forces transitional boundary layers as well as the spatio-temporal properties of boundary layer vortical structures is one of the major research areas of the Department of Thermal and Hydrodynamical Modeling of Hydromechanics Institute of Ukrainian National Academy of Sciences. It has been shown that in case of boundary layer flows under centrifugal forces the small parameter depending on the value of these forces can be introduced. Using methods of matching asymptotical expansions the scenarios of the boundary layer development (including transition processes from 2D to 3D) in terms of space scales of their vortical structures have been proposed. In particular, the knowledge about (1) formation mechanisms of 3D vortical structures in boundary layers; (2) spatio-temporal properties of 2D and 3D vortical structures depending on basic flow parameters were obtained.
Author
Boundary Layer Flow; Boundary Layers; Flow Characteristics; Vortices

19980020545 Technische Univ., FG Bionik and Evolutionstechnik, Berlin, Germany
EXPERIMENTAL STUDIES ON THE BOUNDARY LAYER DEVELOPMENT IN PENGUINS: MECHANISMS OF TURBULENCE CONTROL AND THEIR APPLICABILITY TO ENGINEERING
Bannasch, R., Technische Univ., Germany; Feb. 1998; 3p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Experimental studies conducted on live penguins as well as measurements with life-sized models of their trunk in a water tank revealed extremely low drag coefficients, although there was some evidence that transition from laminar to turbulent near-wall flow occurred in the most frontal part of their body. At a Reynolds number of 3 x 10(exp 6) the drag coefficients were 20-35% lower than those reported for the best turbulent technical bodies. Contrary to fish and dolphins, the penguin's trunk does not contribute to thrust production. Trunk oscillations during a wing beat cycle are moderate. Therefore, the spindle-like penguin trunk may well serve as live example for how energy may be saved by shape optimization of stiff bodies. The trunk of these birds is relatively short and thick, thus offering a large volume with minimum drag. Using the arithmetic means of data on body geometry from three medium sized penguin species, an axisymmetric body was constructed. by drag measurements in a water tank, this body of revolution was found to be an excellent low-drag laminar body (e.g. the lowest frontal drag coefficient was c(sub wf) = 0,0156, measured at Re(sub D) = 2,331 x 10(exp 5). When the transition from laminar to turbulent flow was triggered at 5% of the body length the surface drag coefficients remained even lower than those of a turbulent flat plate of equal length, and with increasing Reynolds numbers they declined at a higher rate. Detailed studies on boundary layer development suggested that drag reduction resulted from the multiple curved (wavelike) outlines of the body. Due to alternating concave and convex parts, a stepwise pressure and velocity distribution was developed. Thereby, the thickness as well as the boundary layer in the turbulent velocity fluctuations within the boundary layer could be managed to keep the wall shear stress low. Hypothetically, by this mechanism, the vertical exchange of energy can be managed in a way that the boundary layer receives energy from the outer flow just sufficient to prevent flow separation.
Author
Aerodynamic Drag; Laminar Flow; Transition Flow; Axisymmetric Bodies; Turbulent Flow; Boundary Layer Control; Turbulent Boundary Layer; Boundary Layer Transition

19980020546 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
COMPLIANT COATINGS FOR TRANSITIONAL BOUNDARY LAYER CONTROL
Yurchenko, N., Academy of Sciences of the Ukraine, Ukraine; High Speed Body Motion in Water; Feb. 1998; 8p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Visco-elastic properties of various materials and combinations of their layers were measured, results having been presented by stress-strain characteristics for samples defined by density, porosity, and layer thickness. To estimate the flow-surface interaction and to compare compliant coatings, they were characterized by nondimensional parameters describing their inertial, viscoelastic, and damping properties. Boundary-layer vortex dynamics was studied experimentally in a water channel over flat and concave, rigid and compliant surfaces at natural transition to turbulence and under the generation of longitudinal vortices. Compared to the rigid plate case, boundary layers over compliant surfaces were found to have a larger scale vortical structure. Besides, boundary layers over compliant surfaces demonstrated lower receptivity to external disturbances.
Author
Boundary Layer Control; Turbulent Boundary Layer; Vortices; Turbulence; Surface Reactions; Viscoelasticity; Boundary Layer Transition

19980020547 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
DYNAMICS OF VORTICES IN NEAR-WALL FLOWS: EIGENFREQUENCIES, RESONANT PROPERTIES, ALGORITHMS OF CONTROL
Gorban, V., Academy of Sciences of the Ukraine, Ukraine; Gorban, I., Academy of Sciences of the Ukraine, Ukraine; High Speed Body Motion in Water; Feb. 1998; 11p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Some ways of control of near-wall flow characteristics are analysed. They are based on generation in the flow of large vortical structures with special dynamic properties. In this connection, dynamics of 2-D stationary vortices located near the flow boundary irregularities are investigated by numerical simulation using the model of ideal incompressible fluid. Parameters of standing vortices in a cavity, behind a bulge, over a wavy wall, in the wake of a cylinder were calculated and the classification of stationary points for corresponding areas was made. The vortex located in the stationary point that was shown has the characteristic eigenfrequency. It leads to resonant interaction of the vortex with external perturbations, when the vortex frequency is similar to that of the perturbation. to generate the stationary vortices near a body, it is proposed to use special cavities (vortex chambers). Patterns of the flow near the wall with the cavity were obtained by the discrete vortex method. The steady standing vortex above a flat plate can be achieved in the active control system of pulsed sources with feedback.
Author
Dynamic Characteristics; Flow Characteristics; Wall Flow; Turbulent Flow; Boundary Layer Control; Trapped Vortices

19980020548 Istituto Nazionale di Studi Espe Architettura Navale, Italian Ship Model Basin, Rome, Italy
A SIMPLE MODEL FOR THE AERO-HYDRODYNAMICS OF EKRANOPLANS
Bulgarelli, U. P., Istituto Nazionale di Studi Espe Architettura Navale, Italy; Greco, M., Istituto Nazionale di Studi Espe Architettura Navale, Italy; Landrini, M., Istituto Nazionale di Studi Espe Architettura Navale, Italy; Lugni, C., Istituto Nazionale di Studi Espe Architettura Navale, Italy; High Speed Body Motion in Water; Feb. 1998; 10p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The problem of a wing-shaped body moving close to the air-water interface is addressed in terms of an inviscid-rotational model in which the aerodynamic problem is coupled to the water flow by means of suitable interface conditions. A numerical procedure to solve the nonlinear unsteady problem is described. Numerical examples are given for some linearized cases. In particular the steady flow generated by a flat plate at incidence in forward motion over calm water is studied at first. The linearized wave-wing interaction is then analized in the frequency domain.
Author
Boundary Conditions; Wave Interaction; Iterative Solution; Mathematical Models; Wings; Computerized Simulation; Liquid-Vapor Interfaces

19980020549 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
ABOUT MOVEMENT OF A WING ABOVE WAVY SURFACE OF WATER
Belynsky, V. G., Academy of Sciences of the Ukraine, Ukraine; Feb. 1998; 9p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In the work, the outcome of an experimental research study on hydrodynamical characteristics of a wing driven above a wavy screen are represented. The description of experimental installation and techniques of realization of the experiment is given. The instantaneous significance of a lift coefficient for wings of the rectangular form in the plan, various elongations driven with various angles of attack on various distances from a flat screen and a screen, consisting of waves of sinusoidal structure of various length and height, are determined. The dependence of a lift coefficient of a wing form Strouhal number for movement above a wave screen is established. It is shown, that there is additional, not known earlier, gain of lift of a wing stipulated by the wavy form of the surface of water. The efficiency of a flap near to the screen is also discussed.
Author
Surface Water; Hydrodynamic Coefficients; Water Waves; Surface Waves; Wings

19980020550 Tsentralni Aerogidrodinamicheskii Inst., Moscow, USSR
SOME PROBLEMS OF SUPERCAVITATING FLOWS
Logvinovich, G. V., Tsentralni Aerogidrodinamicheskii Inst., USSR; Feb. 1998; 5p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Now, due to the immense success of the computer hydrodynamic it is useful to consider some fundamental physical statements. The types of cavitating flows, reentrant jets, energy conservation principles, and cavity pulsation at cavitation are presented.
Author
Supercavitating Flow; Hydrodynamics

19980020551 California Univ., Ocean Engineering Lab., Santa Barbara, CA United States
CAVITY SHAPES IN THREE DIMENSIONS
Tulin, M. P., California Univ., USA; High Speed Body Motion in Water; Feb. 1998; 8p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Cavitating and ventilated bodies produce trailing cavities of a length and volume out of all proportion to the dimensions of the body itself. The shape and dimensions of these cavities have attracted research interest which is intensified by the engineering of high speed bodies enveloped by their cavities in order to reduce their resistance. In his introductory work on the linearized, or thin body, theory of planar supercavitating flows, the present author obtained asymptotic results defining the cavity shape, Tulin (1953). It was shown that the trailing planar cavity behind a head form was asymptotic in shape to a slender elliptic cylinder whose length, l, and thickness, T, depend in a simple way on the body drag coefficient, C(sub D), and cavitation number, (sigma)<1: (1): l/t is approx. = (8/pi)C(sub D)/ sigma(exp 2) and T/t is approx. = (4/pi)C(sub D)/sigma where, t is a characteristic length of the body. Later, Tulin (1956), it was shown that in the case of a lifting foil, only the symmetric part of the flow field (i.e. strut-like) entered into the determination of the drag and cavity length. A few years later, Garabedian (1956) obtained corresponding results for axisymmetric bodies like cones: (2): (l/d)(exp 2) is approx. = C(sub D)/sigma(exp 2) x natural log of 1/sigma. (T/d)(exp 2) is approx. = to C(sub D)/sigma where d is the diameter pf the base of the cone forebody and C(sub D) is nondimensionalized with the base area. The shape of the trailing cavity is essentially spheroidal. Here we derive a generalization of (1) and (2) to the case of genuinely three dimensional headforms. It is clear that all possible head shapes are unlikely to shed cavities of the same general characteristics. For example, delta wings produce cavities with the appearance of a re-entrant jet along the top axis of symmetry, Tulin (1955), while rectangular wings produce smooth trailing cavities with the addition of strong cavitating tip vortices. As a prototype headform we consider a wing of elliptical shape, span W and midchord C. The aspect ratio, AR, of the wing is W/C. This headform seems likely to produce a trailing cavity of basically ellipsoidal shape.
Author
Cavitation Flow; Hydrodynamics; Cavities; Three Dimensional Bodies

19980020552 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
INVESTIGATION OF HIGH-SPEED SUPERCAVITATING UNDERWATER MOTION OF BODIES
Savchenko, Yu. N., Academy of Sciences of the Ukraine, Ukraine; Feb. 1998; 12p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The main hardware of the institute of Hydromechanics of UNAS for research of high-speed super cavitating motion in water are presented. These are the 35 m launching tanks with electrochemical catapult, the vertical tank to investigate water entry, the hydrodynamic tunnel of open type. Cinegrams of supercavity obtained at underwater motion of supercavitating models for speeds up to 1360 m/s (0.93M) are demonstrated. The hydrodynamic effects connected with supercavitating motion of objects and their stability are discussed.
Author
High Speed; Supercavitating Flow; Water Tunnel Tests; Cavities; Flow Stability

19980020553 Tsentralni Aerogidrodinamicheskii Inst., Moscow, USSR
SUPERCAVITATING FLOWS AT SUPERSONIC SPEED IN COMPRESSIBLE WATER
Vasin, A. D., Tsentralni Aerogidrodinamicheskii Inst., USSR; Feb. 1998; 10p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In the beginning I discuss basic results obtained in the theory of supercavities in compressible fluid, then I present the features of supersonic flow. Since 1980 in the USSR interest has arisen to supercavities in compressible fluid. On the basis of the slender body theoretical studies have been made. On the basis of the early numerical method Al'ev has calculated cavity past a thin cone. The recent development of numerical methods and the widespread use of computers has made it possible to calculate compressible cavitation flows efficiently.
Author
Cavities; Compressible Fluids; Supercavitating Flow; Supersonic Speed; Supersonic Flow

19980020554 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
COMPUTER SIMULATION OF UNSTEADY SUPERCAVITATING FLOWS
Semenenko, V. N., Academy of Sciences of the Ukraine, Ukraine; Feb. 1998; 10p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A mathematical model of unsteady axisymmetrical supercavitating flow and an algorithm of numerical solution as well as corresponding computer programs are described. Examples of computer simulation of the unsteady supercavitating flows are presented.
Author
Algorithms; Axisymmetric Flow; Computerized Simulation; Mathematical Models; Supercavitating Flow; Unsteady Flow

19980020555 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
SOME PROBLEMS OF THE SUPERCAVITATION THEORY FOR SUB OR SUPERSONIC MOTION IN WATER
Serebryakov, V. V., Academy of Sciences of the Ukraine, Ukraine; Feb. 1998; 20p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Main concepts, results and methods of the linearized theory of axisymmetric supercavitation are presented on the basis of the slender body approximation in incompressible fluid. Because of the considerable increase of possible velocities of motion in water up to values comparable with the sonic velocity, an effort is made to apply the approach developed here to the analysis of supercavitation flows taking into account basic effects of compressibility.
Author
Supercavitating Flow; Supersonic Flow; Mathematical Models; Incompressible Flow; Hydrodynamics; Cavities

19980020556 Norwegian Univ. of Science and Technology, Dept. of Marine Hydrodynamics, Trondheim, Norway
WATER ENTRY OF SHIP SECTIONS AND AXISYMMETRIC BODIES
Faltinsen, Odd, Norwegian Univ. of Science and Technology, Norway; Zhao, Rong, Norwegian Marine Technology Research Inst., Norway; Feb. 1998; 11p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Theoretical methods for water entry of two-dimensional and axisymmetric bodies are presented. When the local angle between the water surface and the body surface is very small, hydroelasticity must be considered. The presented slamming analysis assumes the structure is rigid. Two 2-D numerical methods are discussed. One of the methods simplifies the dynamic free surface condition and details of the jet flow. Flow separation from sharp corners are incorporated. The simplified method is generalized to 3-D axisymmetric flow without flow separation. In order to verify the 3-D method, water entry of axisymmetric bodies with small local deadrise angles are studied analytically by means of matched asymptotic expansions. A composite solution for the pressure is presented. The numerical method is verified by comparing with the asymptotic method and validated by comparing with experiments for cones and spheres. It is demonstrated that satisfaction of exact body boundary condition is more important than satisfaction of exact free surface conditions. The effect of local rise up of the water is significant.
Author
Axisymmetric Bodies; Axisymmetric Flow; Boundary Conditions; Boundary Layer Separation; Two Dimensional Bodies; Slamming; Water Flow; Ships

19980020557 Ecole Centrale de Nantes, France
ASYMPTOTIC THEORIES OF INCOMPRESSIBLE WATER ENTRY
Fontaine, E., Ecole Centrale de Nantes, France; Cointe, R., Ministere de l'Environnement, France; Feb. 1998; 8p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The problem of a two-dimensional body impacting a free surface is studied using potential theory. When the angle (or its tangent) between the body and the free surface is very small, i.e. when the free surface and the body are almost parallel, the method of matched asymptotic expansions provides a first order composite solution. This solution includes three subdomains: the far-field, the spray root and the jet domains. This asymptotic solution appears to be a good approximation of the nonlinear solution, even for large values of the small parameter. In this paper, the asymptotic expansion for a wedge with small deadrise angle is extended up to second order for the far-field problem. This allows the jet volume to be taken into account within the composite solution. Then, a direct time domain simulation of the problem is performed using a mixed Eulerian-Lagrangian method. In order to overcome the numerical difficulties that arise at the body-free surface intersection, a special numerical treatment is introduced, based on the asymptotic solution describing the jet. This treatment allows the influence of the jet to be accounted for without having to actually compute the flow in the jet.
Author
Asymptotic Methods; Potential Theory; Mathematical Models; Incompressible Flow; Jet Flow; Water Flow

19980020558 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
STABILITY OF SUPERCAVITATING SLENDER BODY DURING WATER ENTRY AND UNDERWATER MOTION
Putilin, S. I., Academy of Sciences of the Ukraine, Ukraine; High Speed Body Motion in Water; Feb. 1998; 14p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes the main results of experimental and theoretical investigations of slender body motion stability when it enters water and moves underwater in supercavitation conditions. Experimental investigations were used to study flows occurring in the situation considered and provide data for developing mathematical models of flows. Previously known theoretical relations for forces, acting on the body are defined more exactly and new ones are derived. A mathematical model of body motion in the supercavitating regime is provided.
Author
Supercavitating Flow; Motion Stability; Mathematical Models; Underwater Tests; Water Tunnel Tests; Slender Bodies

19980020559 Centre Technique des Systemes Navals, Toulon Naval, France
EMERGENCE OF CAVITATING PROFILE
Arnaud, M., Centre Technique des Systemes Navals, France; Dieval, L., Centre Technique des Systemes Navals, France; High Speed Body Motion in Water; Feb. 1998; 8p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The paper presents a numerical method for unsteady cavitation simulation around engines moving with large vertical velocity. The numerical modelling of the creation and the development of the cavitating flow zones attached to the profile, as well as the free surface deformation, is done using an interface tracking method of, Volume of Fluid, type, inserted into a Navier-Stokes code. Results show that the model is well adapted to simulate this complex physical phenomena.
Author
Computerized Simulation; Cavitation Flow; Navier-Stokes Equation; Mathematical Models; Fluid Boundaries

19980020560 Academy of Sciences of the Ukraine, Inst. of Mathematical Machines and Systems Problems, Kiev, Ukraine
REDUCTION OF OVERLOAD ON A BODY ENTERING WATER AT HIGH SPEED
Savchenko, V. T., Academy of Sciences of the Ukraine, Ukraine; High Speed Body Motion in Water; Feb. 1998; 6p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

An object at high speed entering water experiences significant overloads caused by sharp increases in density of the environment. In the present paper we consider two angles - the entrance angle (Theta) between a trajectory of body gravity center and a free surface; the attack angle (alpha) between the body's axis and direction of motion. So a whole hydrodynamic force F can be presented as a drag (axial) force X and a significant lift (lateral) force Y. Surrounding an object by a supercavity allows us to solve the series of problems, including the following: reducing hydrodynamic drag; reducing or eliminate destructive lift(lateral) loads for the object's appendage elements (ledges); damping(restrain) impact loads concentrated primarily on a cavitator. The presented research offers information based upon the results of the experiment's technical design for the new series of two-medium foils. Such foils provide the protection of stabilizers and rudders of two-medium apparatuses from destructive hydrodynamic forces.
Author
Hydrodynamics; High Speed; Impact Loads; Water; Flow Stability

19980020561 Technische Univ., Munich, Germany
CAVITATION SCALE EFFECTS: A REPRESENTATION OF ITS VISUAL APPEARANCE AND EMPIRICALLY FOUND RELATIONS
Keller, Andreas P., Technische Univ., Germany; High Speed Body Motion in Water; Feb. 1998; 10p; In English; See also 19980020532; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Incipient cavitation was measured on four rotational symmetric test body families and a NACA 16020 profile at four different angles of attack, varying the size of the test bodies, the free stream velocity, the viscosity, and the free stream turbulence level. by these experiments, it was determined that all four parameters have strong effect on the cavitation inception of submerged bodies. The dependencies of the cavitation number on these parameters are called scale effects. As a prerequisite, the normally covering effect of the water quality, concerning its cavitation susceptibility, had to be got under control. This was achieved by measuring the tensile strength of the test water by means of vortex nozzle instrument. The relations deduced from the experimental results lead to empirical scaling relations of stunning simplicity.
Author
Submerged Bodies; Cavitation Flow; Flow Velocity; Scale Effect; Turbulence

19980020562 Ecole Nationale Superieure de Techniques Avancees, Groupe Phenomenes d'Interface, Paris, France
TIP VORTEX ROLL-UP AND CAVITATION IN WATER AND POLYMER SOLUTIONS
Fruman, Daniel H., Ecole Nationale Superieure de Techniques Avancees, France; Billard, Jean-Yves, Laboratoire d'Hydrodynamique Navale, France; High Speed Body Motion in Water; Feb. 1998; 10p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Results of experiments performed by ejecting semi-dilute drag reducing polymer solutions from an orifice situated at the tip of an elliptical hydrofoil are reported. It is demonstrated that the conditions for tip vortex cavitation occurrence are substantially modified by the ejection of very small flow rates of the polymer solutions while non appreciable alteration occurred when pure water is ejected. In order to investigate the causes of the cavitation inhibition effect, axial and tangential velocity profiles along the tip vortex in the very near region, comprised between the tip and one maximum chord downstream, were measured using Laser Doppler Anemometry. Statistical information on the moments and cross moments of the velocity fluctuations were also obtained. The ejection of the polymer solution results in the widening of the viscous core of the tip vortex, where the tangential velocities are reduced as compared to the pure water situation and the axial velocities display a marked wake effect. Changes are also apparent on the root mean square and skewness of the velocity fluctuations and on the cross moment of the axial and tangential velocity fluctuations. Analysis of the data indicates that the velocity modifications may be associated to the swelling of the polymer solution when issuing from the orifice. The changes of the velocity fluctuation and cross moments shows that they are essentially caused by the spatial bias introduced by the finite dimension of the measuring volume and the wandering of the vortex; "true" turbulence being a relatively small additional effect. by simulating the spatial bias effect it is shown that the ejection of the polymer solution results in a nearly complete suppression of the "true" turbulence in the core region.
Author
Cavitation Flow; Hydrodynamics; Drag Reduction; Hydrofoils; Turbulence; Orifices; Polymers; Water; Solutions; Ejection; Vortices

19980020563 Academy of Sciences of the Ukraine, Inst. of Technical Mechanics, Dnepropetrovsk, Ukraine
CAVITATION SELF-OSCILLATIONS INTENSIFY TECHNOLOGICAL PROCESSES
Pilipenko, V. V., Academy of Sciences of the Ukraine, Ukraine; Manko, I. K., Academy of Sciences of the Ukraine, Ukraine; Zatonsev, V. A., Academy of Sciences of the Ukraine, Ukraine; Feb. 1998; 4p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Characteristic features are presented for high frequency, high-amplitude self-oscillations in a hydraulic system with a local hydraulic resistance of a venturi nozzle type whose physical nature is due to a periodically - stalled cavitation (growth, break-off, carry-over and collapse of a cavity diffuser-like part). Analytical expressions are given to determine the frequencies and amplitudes of pressure oscillations occurring in the hydraulic system with a local hydraulic resistance under realization of the periodically- stalled cavitation regime. The possibility to utilize cavitation self- oscillations for various technological processes intensification is shown.
Author
Pressure Oscillations; Cavitation Flow; Hydraulic Equipment; Cavities; Flow Characteristics; Nozzle Flow; Flow Resistance

19980020564 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
CONTROL OF CAVITY PARAMETERS AT SUPERCAVITATING FLOW
Vlasenko, Yu. D., Academy of Sciences of the Ukraine, Ukraine; High Speed Body Motion in Water; Feb. 1998; 10p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Some methods of control of fully developed cavity parameters by varying geometrical characteristics of a cavitating body are considered. Results of experimental investigations of cavitators with variable frontal drag and constant edge of free streamline separation and also some types of nonsymmetrical cavitators are presented. The possibility and a number of features of the fully developed cavity control independently on the cavitation number and cavitation regime (vapor or gas) are shown.
Author
Supercavitating Flow; Cavities; Vapors; Gas Flow; Flow Characteristics; Cavity Flow

19980201044 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
A SELECTION OF TEST CASES FOR THE VALIDATION OF LARGE-EDDY SIMULATIONS OF TURBULENT FLOWS *QUELQUES CAS D'ESSAI POUR LA VALIDATION DE LA SIMULATION DES GROS TOURBILLONS DANS LES ECOULEMENTS TURBULENTS*
Apr. 1998; 211p; In English; CD-ROM conforms to the ISO 9660 standard
Report No.(s): AGARD-AR-345; ISBN 92-836-1072-5; Copyright Waived; Avail: CASI; A10, Hardcopy; A03, Microfiche

The results of the AGARD FDP Working Group 21 on "A Selection of Test Cases for the Validation of Large Eddy Simulations of Turbulent Flows" are presented in this report. The data contained in the report consist of building-block experiments documented in as much detail as possible. They are useful for the validation of Reynolds Averaged modeling and for the preliminary evaluation of experiments or turbulence theories. They include both laboratory experiments and direct numerical simulations. The introductory chapters are complemented by data sheets which describe in detail each data set, the experimental or numerical procedures, the expected errors, and the initial and boundary conditions. The data are given in machine-readable form in the CD-ROM that accompanies the report.
Author
Large Eddy Simulation; Turbulent Flow; Computational Fluid Dynamics; Turbulence Models; Direct Numerical Simulation; Reynolds Averaging; Homogeneous Turbulence; Shock Wave Interaction; Shear Layers; Pipe Flow; Computerized Simulation; Mathematical Models; Flow Distribution

19980203585 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
CFD VALIDATION FOR PROPULSION SYSTEM COMPONENTS *LA VALIDATION CFD DES ORGANES DES PROPULSEURS*
May 1998; 96p; In English; Original contains color illustrations
Report No.(s): AGARD-AR-355; ISBN 92-836-1075-X; Copyright Waived; Avail: CASI; A05, Hardcopy; A01, Microfiche

Computer codes which solve the Reynolds-averaged Navier-Stokes equations are now used by manufacturers to design turbomachines, but there is no consensus about which grids and which turbulence models are good enough to provide a reliable basis for design decisions. The AGARD Propulsion and Energetics Panel set up Working Group 26 to help to clarify these issues, by analysing predictions (using as wide a range of codes as possible) of two representative but difficult single blade row test cases: NASA Rotor 37 and an annular turbine cascade tested by DLR. This report presents the

Group's results and conclusions. Recommendations are made about the type and density of grid, which depend on many factors. Mixing-length turbulence models are unsuitable for turbomachines with their complex endwall flows; some kind of turbulent transport model is essential. No turbulence model was found which always gave good loss predictions.
Author
Computational Fluid Dynamics; Computer Programs; Turbulence Models; Mixing Length Flow Theory; Annular Flow

19980203986 Imperial Coll. of Science Technology and Medicine, Dept. of Mechanical Engineering, London, United Kingdom
REVIEW OF OPTICAL METHODS FOR FLUID DYNAMICS
Heyes, A. L., Imperial Coll. of Science Technology and Medicine, UK; Whitelaw, J. H., Imperial Coll. of Science Technology and Medicine, UK; May 1998; 18p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

There are many methods for measuring the velocity, pressure and temperature characteristics of the flows around solid bodies and this paper considers their relative advantages with special consideration of the needs of wind tunnels. The emphasis is on optical techniques for which brief descriptions of the principles and requirements are provided together with an indication of applications and their findings.
Author
Fluid Dynamics; Velocity Measurement; Pressure Measurement; Optical Flow (Image Analysis); Optical Measurement; Wind Tunnel Tests

19980203990 German-Dutch Wind Tunnel, Emmeloord, Netherlands
APPLICATION OF PIV IN THE LARGE LOW SPEED FACILITY OF DNW
Kooi, J. W., German-Dutch Wind Tunnel, Netherlands; Pengel, K., German-Dutch Wind Tunnel, Netherlands; Raffel, M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Willert, C., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Kompenhans, J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; May 1998; 12p; In English; See also 19980203985; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Particle Image Velocimetry (PIV) is a non-intrusive measurement technique capable of measuring the instantaneous velocity field in a two-dimensional plane. This technique has matured to a state that it now can be employed on a routine basis in large industrial wind tunnels. For that reason, the German Dutch Wind Tunnel has acquired a two-component PIV system for its Large Low Speed Facility. The main components of the system are a high speed video camera, a powerful pulsed Nd:YAG laser and for evaluation of the recordings a software system. The tracer particles are introduced in the flow by means of a rake mounted in the wind-tunnel settling chamber. A first application of the PIV system was the measurement of the trailing wake of transport type aircraft model. The measurement plane was positioned perpendicular to the main flow direction and the video camera was mounted on a traversing system installed inside the test section far downstream of the model. One of the important results was that in the individual velocity plots an unsteady vortex was found almost absent in the time averaged results. The PIV system cannot only be used in the closed wall test section of the DNW-LLF, but also in the Open Jet test section. Because of the large size of the facility the set-up requires both for the video camera and the pulse laser a stable support. This could be realised by using existing support systems.
Author
Particle Image Velocimetry; Nonintrusive Measurement; YAG Lasers; Low Speed Wind Tunnels; Velocity Measurement; Two Dimensional Flow

19980203991 Glasgow Univ., Dept. of Aerospace Engineering, United Kingdom
ANALYSIS OF COMPLEX FLOW FIELDS BY ANIMATION OF PIV AND HIGH RESOLUTION UNSTEADY PRESSURE DATA
Coton, F., Glasgow Univ., UK; Galbraith, R., Glasgow Univ., UK; Grant, I., Heriot-Watt Univ., UK; Hurst, D., Glasgow Univ., UK; May 1998; 10p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes the use of animation in the analysis of data from unsteady aerodynamic tests where the phenomena of interest vary both temporally and spatially. Particular emphasis is given to results from an investigation of blade vortex interaction (BVI) where both flow field and surface pressure data were recorded. It is shown that animation can be used, in a manner akin to basic flow visualisation, to identify the interesting features of such a flow and to, thus, guide more detailed conventional analysis techniques. The method adopted in this study involved the acquisition of a series of PIV images which were then processed and subsequently interpolated onto a regular grid. The temporal variation in velocity at each grid point was then established by a further interpolation between PIV frames. Finally, particles were placed in the initial velocity field and their subsequent trajectory during the interaction process calculated using a multi-step integration method.
Author
Particle Image Velocimetry; Flow Distribution; Velocity Distribution; Unsteady Aerodynamics; Pressure Measurement; Velocity Measurement; Flow Visualization; Aerodynamics

19980203992 NASA Ames Research Center, Moffett Field, CA United States
RECENT ADVANCES IN PARTICLE IMAGE VELOCIMETRY
Lourenco, L., Florida State Univ., USA; Krothapalli, A., Florida State Univ., USA; Smith, C. A., NASA Ames Research Center, USA; May 1998; 12p; In English; See also 19980203985; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents new trends in Particle Image Velocimetry and practical aspects relevant to the application of the technique to large scale wind tunnel testing. The various problems and their solutions to the operation of PIV in large scale wind tunnels are discussed. Application of the technique in mapping complex flows are also presented.
Author
Particle Image Velocimetry; Wind Tunnel Tests; Trends; Flow Visualization; Imaging Techniques; Laser Doppler Velocimeters

19980203993 Wright Lab., FIMO, Wright-Patterson AFB, OH United States
RECENT DEVELOPMENTS IN DOPPLER GLOBAL VELOCIMETRY
Beutner, Thomas J., Wright Lab., USA; Baust, Henry D., Wright Lab., USA; May 1998; 10p; In English; See also 19980203985; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Doppler Global Velocimetry is a non-intrusive wind tunnel diagnostic technique which has the potential to make simultaneous three-component velocity measurements over entire planes in the flow field. Measurements of velocity are based on determining the Doppler shift of single frequency laser light scattered off particles in the flow field. This technique has been used in the Subsonic Aerodynamic Research Laboratory wind tunnel at Wright Laboratory to make qualitative measurements of the flow associated with a vortex-tail interaction. This flow field is typical of the flows seen on twin-tail fighter aircraft. This paper presents results obtained with the DGV instrument and reports the current progress and recommendations towards developing an improved diagnostic system.
Author
Aerodynamics; Velocity Measurement; Nonintrusive Measurement; Doppler Effect

19980203994 NASA Ames Research Center, Moffett Field, CA United States
PLANAR DOPPLER VELOCIMETRY FOR LARGE-SCALE WIND TUNNEL APPLICATIONS
McKenzie, Robert L., NASA Ames Research Center, USA; May 1998; 14p; In English; See also 19980203985; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Planar Doppler Velocimetry (PDV) concepts using a pulsed laser are described and the obtainable minimum resolved velocities in large-scale wind tunnels are evaluated. Velocity-field measurements are shown to be possible at ranges of tens of meters and with single pulse resolutions as low as 2 m/s. Velocity measurements in the flow of a low-speed, turbulent jet are reported that demonstrate the ability of

PDV to acquire both average velocity fields and their fluctuation amplitudes, using procedures that are compatible with large-scale facility operations. The advantages of PDV over current Laser Doppler Anemometry and Particle Image Velocimetry techniques appear to be significant for applications to large facilities.
Author
Particle Image Velocimetry; Velocity Measurement; Wind Tunnel Tests

19980203995 Institut de Mecanique des Fluides de Lille, France
THE ADVANTAGE OF USING A TUNABLE LASER SOURCE FOR GLOBAL DOPPLER VELOCITY MEASUREMENT *INTERET DE L'UTILISATION D'UNE SOURCE LASER ACCORDABLE EN VELOCIMETRIE DOPPLER GLOBALE*
Leporcq, B., Institut de Mecanique des Fluides de Lille, France; LeRoy, J.-F., Institut de Mecanique des Fluides de Lille, France; Pinchemel, B., Universite des Sciences et Techniques de Lille, France; Hostyn, S., Institut de Mecanique des Fluides de Lille, France; May 1998; 12p; In French; See also 19980203985; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The global doppler velocity meter is a non-intrusive method based on measurement of the doppler shift of a light diffused by a flow made of particles illuminated by a flat laser beam at frequency nu. Observed through an iodine cartridge any doppler shift is translated immediately into a variation of light absorption. This technique allows one to obtain the velocity field of the embedded flow of particles at an acquisition rate which depends only on the recording equipment. The studies which have been carried out to date make use of a single-mode ionized argon laser in which the green emission line is fortuitously tuned to two unresolved absorption lines of the iodine whose strength depends greatly on temperature. In order to avoid this obstacle a continuous dye laser tunable by frequency was used, which gives one an extremely easy choice of an absorption line of a molecule in which the population is almost not dependent on temperature and the profile is more or less steep as a function of the velocity range to be measured. The first tests were conducted on a rotating disk, the speeds determined by a global doppler velocity meter are in good agreement with that measured by a tachometer, and then measurements were conducted in a wind tunnel. A summary is given of the improvements made to increase the precision.
Transl. by Schreiber
Tunable Lasers; Particle Image Velocimetry; Velocity Measurement; Nonintrusive Measurement; Doppler Effect; Continuous Wave Lasers

19980203998 Office National d'Etudes et de Recherches Aerospatiales, Palaiseau, France
MOLECULAR DIAGNOSTICS FOR RAREFIED FLOWS
Taran, J. P., Office National d'Etudes et de Recherches Aerospatiales, France; May 1998; 15p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The paper reviews the various optical techniques which can be applied for point, line of sight or imaging measurements. In the category of point measurements, light scattering methods like Raman, Rayleigh or Electron Beam Fluorescence (EBF) are treated first, but briefly since they are of little use, especially when enthalpy is very high and flow naturally bright. The emphasis is placed instead on nonlinear laser spectroscopy like Coherent anti-Stokes Raman Scattering (CARS), which has recently achieved great success at getting temperatures and density in high enthalpy shocks. Then, the diode laser absorption spectroscopy is described. A high data rate instrument now gives, on a routine basis, the static temperature and the velocity of the stream in the hot shot facility F4 of ONERA, at stagnation enthalpies in excess of 15 MJ/kg. EBF imaging in that same facility has permitted measurements of velocity to be performed across the external boundary layer into the flow core thanks to a high energy pulsed electron gun. Finally, the technique of Collective Light Scattering is briefly described and its capabilities demonstrated.
Author
Rarefied Gas Dynamics; Molecular Flow; Absorption Spectroscopy

19980203999 Office National d'Etudes et de Recherches Aerospatiales, Palaiseau, France
ROTATIONAL AND VIBRATIONAL TEMPERATURES AND DENSITY MEASUREMENTS BY COHERENT ANTI-STOKES RAMAN SCATTERING IN A NONEQUILIBRIUM SHOCK LAYER FLOW
Grisch, F., Office National d'Etudes et de Recherches Aerospatiales, France; Bouchardy, P., Office National d'Etudes et de Recherches Aerospatiales, France; Koch, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Guelhan, A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; May 1998; 10p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Coherent anti-Stokes Raman scattering studies are carried out in a nonequilibrium shock layer air flow induced by a two-dimensional body. Rovibrational spectra of molecular nitrogen are recorded by scanning CARS in the free stream and within the shock layer at moderately high enthalpy (7.3 MJ/kg). Difficulties peculiar to the application of the optical technique to a high enthalpy flow are discussed and flow parameters are given. The rotational temperature, vibrational temperature and number density are measured and compared to theoretical values predicted by a Navier-Stokes solver. A good agreement is found.
Author
Navier-Stokes Equation; Shock Layers; Vibration; Air Flow; Coherent Scattering

19980204001 Institute for Aerospace Research, Aerodynamics Lab., Ottawa, Ontario Canada
TIME RESOLVED MEASUREMENTS OF THE ENERGY SEPARATION PROCESS IN A TRANSONIC TURBINE VANE WAKE FLOW
Carscallen, W. E., Institute for Aerospace Research, Canada; Hogg, S. I., Leicester Univ., UK; Gostelow, J. P., Leicester Univ., UK; Buttsworth, D. R., Oxford Univ., UK; May 1998; 12p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes the application of a new, fast response, stagnation temperature probe and the associated measurement technique to an unsteady transonic turbine vane wake flow in which energy separation occurs due to vortex shedding.
Author
Supersonic Turbines; Wakes; Turbulence; Time Measurement

19980204005 Technische Univ., Dept. of Aerospace Engineering, Delft, Netherlands
HOLOGRAPHIC AND TOMOGRAPHIC INTERFEROMETRY FOR THE STUDY OF UNSTEADY COMPRESSIBLE FLOWS
Timmerman, B. H., Technische Univ., Netherlands; Bakker, P. G., Technische Univ., Netherlands; May 1998; 8p; In English; See also 19980203985
Contract(s)/Grant(s): NSF ECS-89-10350; STW Proj. DLR33.3109; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A digital holographic interferometry technique is presented which provides non-intrusive, quantitative measurements of the density distribution in a compressible flow field. Using a pulsed laser, flow fields may be essentially frozen, so that a measurement is obtained for a whole field at a single instant. Thus, unsteady, turbulent flow fields may also be studied. The technique provides a measurement of the density projected along the light path, so that the local density may be determined for two-dimensional and axisymmetric flows. Even for relatively complicated flow fields, quantitative projection data may thus be obtained. by sending several probe beams through a flow field simultaneously at different angles, the instantaneous three-dimensional density distribution in unsteady fields may also be obtained using tomographic reconstruction techniques. to furthermore gain insight into the temporal behaviour of turbulent flows, quantitative differential recordings can also be made. Thus, the technique presented here may be used to examine the (instantaneous) three-dimensional structure of a density field as well as its fluctuations in time. to illustrate the technique, results are presented here for the supersonic flow around a re-entry body, for an under-expanded free jet flow and for an oscillating flow issued by a so-called pipe-collar nozzle.
Author
Compressible Flow; Supersonic Flow; Reentry Vehicles; Nonintrusive Measurement; Holographic Interferometry; Flow Distribution

19980204007 Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands
WALL-SHEAR STRESS MEASUREMENT WITH QUANTITATIVE IR-THERMOGRAPHY
Mayer, R., Technische Univ., Netherlands; Henkes, R. A. W. M., Technische Univ., Netherlands; vanIngen, J. L., Technische Univ., Nether-

lands; May 1998; 12p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents a new non-intrusive and flexible measurement technique for wall-shear stresses, which is based on the theory of hot-films. To overcome the disadvantage of being limited to a single measurement position like the hot-film, the internal electrical heating and internal temperature detection is replaced by external heating using a laser and external temperature measurement using quantitative infrared thermography, respectively. In this technique the laser is generating a hot spot on the surface of an object. By choosing suitable materials for the solid object with a low thermal conductivity and a high emissivity of thermal radiation a geometrically small but clearly detectable temperature spot can be generated. After the temperature distribution in the solid has become steady, the laser is turned off and the temperature decay of the hot spot is monitored by the camera. From the measured surface-temperature distribution history, the heat transfer to the fluid and the wall-shear stress can be derived by using a numerical procedure. This technique is demonstrated for a Blasius boundary layer in a wind-tunnel experiment, where an accuracy of about 10% has been achieved in the determination of the wall-shear stress.

Author

Shear Stress; Walls; Nonintrusive Measurement; Heating; Thin Films; Infrared Radiometers; Boundary Layers; Stress Measurement

19980204008 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Stroemungsmechanik, Goettingen, Germany

SKIN FRICTION MEASUREMENT AND TRANSITION DETECTION TECHNIQUES FOR THE LUDWIEG-TUBES AT DLR

Schuelein, E., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Koch, S., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Rosemann, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; May 1998; 10p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Three different skin friction measurement and transition detection techniques have been developed and adapted to the specific test conditions in the Ludwieg-Tube facilities of DLR at Goettingen. The latter are: short run time and thin boundary layers for both, the hypersonic Ludwieg-Tube facility (RWG) and the Cryogenic Ludwieg-Tube (KRG), and low temperatures for the KRG, which can be operated down to 120 K to achieve high Reynolds numbers. An oil film technique has been developed and applied to measure skin friction and transition on a flat plate in the RWG at M = 5. The results are in good agreement with the Van Driest II and the Young correlation, respectively, and results from velocity profile measurements for the skin friction and hot-wire measurements for the transition location. Surface mounted hot-films, directly deposited on the model surface, have been used to study shock oscillations on a laminar type airfoil in the KRG down to cryogenic conditions. Further improvements of the deposition quality will make sensor arrays with about 20 sensors on an airfoil section with 150 mm chord available. It could be demonstrated that wall mounted thermocouples provide a simple method to determine transition on airfoils in the KRG by detecting the difference in heat flux between laminar and turbulent boundary layers. The results agree well with the interpretation of pressure distribution and wake measurements as well as with the transition location given by the MSES (Drela) code.

Author

Skin Friction; Airfoils; Airfoil Profiles; Friction Measurement; High Reynolds Number; Laminar Boundary Layer; Hypersonics

19980204009 Technische Univ., Inst. fuer Luft- und Raumfahrt, Berlin, Germany

SURFACE FORCES MEASUREMENTS WITH HIGH SPATIAL AND TEMPORAL RESOLUTION BY MEANS OF LIQUID CRYSTAL FOILS, PIEZOFOILS AND SURFACE HOT-FILM ARRAYS

Nitsche, W., Technische Univ., Germany; Suttan, J., Technische Univ., Germany; Haselbach, F., Technische Univ., Germany; Sturzebecher, D., Technische Univ., Germany; May 1998; 10p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Steady and unsteady surface measurement techniques for subsonic and transonic flows are surveyed emphasizing the capabilities, restrictions and applications of these techniques in experimental aerodynamics. The present paper investigates comparatively the status and capabilities of a number of surface measurement techniques (Liquid Crystals, HotFilm-Arrays, Piezofoil-Arrays,) which are necessary for the understanding of distributed flow phenomena. Based on exemplary results, some of the main features of the measurement techniques are discussed. Emphasis is on recent improvements to obtain higher temporal and spatial resolution. This concerns e.g. the employment of pyroelectrical capabilities for higher signal-to-noise ratios in piezofoil array measurements, or the development of a standard calibration method for multisensor hot-film arrays with small streamwise sensor spacing.

Author

Aerodynamics; Transonic Flow; Subsonic Flow; Signal to Noise Ratios; Liquid Crystals; Crystal Surfaces

19980204010 NASA Ames Research Center, Moffett Field, CA United States

APPLICATION OF OIL FILM INTERFEROMETRY SKIN-FRICTION TO LARGE WIND TUNNELS

Driver, David M., NASA Ames Research Center, USA; May 1998; 10p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The oil film interferometry skin-friction technique is described and applied to flows in some of the NASA Ames large wind tunnel facilities. Various schemes for applying the technique are discussed. Results are shown for tests in several wind tunnels which illustrate the oil film's ability to measure a variety of flow features such as shock waves separation, and 3D flow.

Author

Skin Friction; Interferometry; Thick Films; Oils; Three Dimensional Flow

19980204011 NASA Ames Research Center, Moffett Field, CA United States

VISUALIZATION AND MEASUREMENT OF SURFACE SHEAR STRESS VECTOR DISTRIBUTIONS USING LIQUID CRYSTAL COATINGS

Reda, Daniel C., NASA Ames Research Center, USA; Wilder, Michael C., MCAT Inst., USA; May 1998; 10p; In English; See also 19980203985; Original contains color illustrations

Contract(s)/Grant(s): NAS2-14109; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

When a shear-sensitive liquid crystal coating is illuminated from the normal direction by white light and observed from an oblique above-plane view angle, its color-change response to shear depends on both shear stress vector magnitude and the direction of the applied shear vector relative to the observer's in-plane line of sight. At any point, the maximum color change is always seen or measured when the local shear vector is aligned with, and directed away from, the observer; the magnitude of the color change at this vector/observer aligned orientation scales directly with shear stress magnitude. Conversely, any point exposed to a shear vector with a component directed toward the observer exhibits a noncolor-change response, always characterized by a rusty red or brown color, independent of both shear magnitude and direction. Based on this knowledge, full-surface shear stress vector visualization and measurement methodologies were formulated and successfully demonstrated. The present paper reviews the observations and measurements that led to the development of these methodologies and applications of both are discussed.

Author

Liquid Crystals; Coating; Stress Distribution; Stress Measurement; Flow Visualization

19980204012 Pisa Univ., Dept. of Aerospace Engineering, Italy

SHEAR SENSITIVE LIQUID CRYSTALS IN SUBSONIC AND TRANSONIC WIND TUNNEL TESTING

Lombardi, G., Pisa Univ., Italy; Morelli, M., Council for Scientific and Industrial Research, South Africa; May 1998; 10p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The present paper singles out the advantages connected with the use of the liquid crystal technique for the visualization of the surface flow phenomena during wind tunnel test; they appear significant, and can be summarized in reversibility, non-toxicity and low cost. The more significant benefits are that different types of analysis (boundary layer transition, separation and reattachment, shock wave position) can be performed with a single technique, and that the reversibility of the

process gives the possibility to analyze several conditions in a single run of the wind tunnel. Therefore, the technique is characterized by low cost and time requirements. In any case, it is important to note that several effects can affect the images and this implies a degree of uncertainty in the interpretation of the results. It is therefore necessary to acquire a high confidence level in the technique in order to assure a good degree of repeatability and accuracy in the analysis of the results. Mainly, the use of the technique is related to the visualization of the main feature of the surface flow. In this regard, several examples showing the determination of the boundary layer transition, separation lines and the shock wave position on the surface, are presented. to enhance the knowledge on the boundary layer conditions a quantitative use of this technique will be a powerful tool . Several attempts to Have a quantification of the response of the liquid crystals were carried out and are discussed in the paper. Nevertheless, it is necessary to stress that, at the present state of the research, the technique is proabably non precise enough for an absolute determination of the local shear stress, and the indicated procedure seems applicable only for comparative tests.
Author
Liquid Crystals; Transonic Flow; Subsonic Flow; Wind Tunnels; Shock Waves; Shear Stress; Boundary Layer Transition; Flow Visualization

19980206005 Centre National de la Recherche Scientifique, Lab. de Mecanique des Fluides et d'Acoustique, Ecully, France
LASER TWO-FOCUS FLOW FIELD INVESTIGATION WITHIN A HIGH-SPEED HIGH-PRESSURE CENTRIFUGAL COMPRESSOR
Trebinjac, I., Centre National de la Recherche Scientifique, France; Claudin, I., Centre National de la Recherche Scientifique, France; .Advanced Non-Intrusive Instrumentation for Propulsion Engines; May 1998; 8p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The results of measurements carried out in a transonic centrifugal compressor with splitter vanes are presented and discussed. The laser two-focus anemometry technique is described, including the seeding control which is a crucial issue in a high temperature level environment. Whereas a potential flow structure exists up to the high meridional curvature region, the through flow pattern is largely distorted in the radial part of the impeller. Noticeable differences in flow pattern between both channels are found, particularly through the low momentum fluid zone locations. A qualitative study of the vortical mechanisms ascribes them to the tin clearance effects.
Author
Centrifugal Compressors; Flow Distribution; Laser Anemometers; Transonic Compressors; Flow Measurement; Potential Flow; Velocity Measurement; Nonintrusive Measurement

19980206006 National Technical Univ., Lab. of Thermal Turbomachines, Athens, Greece
3-D LDA MEASUREMENTS IN AN ANNULAR CASCADE FOR STUDYING TIP CLEARANCE EFFECTS
Doukelis, A., National Technical Univ., Greece; Mathiosdakis, K., National Technical Univ., Greece; Founti, M., National Technical Univ., Greece; Papailiou, K., National Technical Univ., Greece; May 1998; 12p; In English; See also 19980206002; Original contains color illustrations; Sponsored in part by CEU
Contract(s)/Grant(s): AERO-CT2-0039; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Literature survey indicates the lack of detailed 3-D flowfield data for high-speed flows inside turbomachines, especially in the region of the tip clearance gap, and points out the difficulties in conducting this kind of measurements. Such information is nevertheless essential in order to validate CFD codes, which give the possibility of understanding the flow and finally producing better designs of efficient turbomachinery components. This paper aims at presenting a 3-D LDA measurement technique, as applied for the measurement of the flowfield in an annular cascade used to study tip clearance effects. First the measurement system layout, signal processing and data acquisition, and processing is presented in detail, together with an evaluation of the measuring accuracy and the measuring capabilities of the system in simple flows. Next the annular cascade configuration is described, together with a detailed account of all the aspects of execution of the measurements and the provisions taken in this study. Finally sample measurements results, demonstrating the kind of information provided, are presented.
Author
Flow Measurement; Turbomachinery; Annular Flow; Cascade Flow; Blade Tips; Clearances; Laser Anemometers; Velocity Measurement; Turbulence; Flow Distribution

19980206008 Centre National de la Recherche Scientifique, Lab. de Mecanique des Fluides et d'Acoustique, Ecully, France
LASER TWO FOCUS ANEMOMETRY (L2F-3D) FOR THREE-DIMENSIONAL FLOW ANALYSIS IN AN AXIAL COMPRESSOR
Vouillarmet, A., Centre National de la Recherche Scientifique, France; Charpenel, S., Centre National de la Recherche Scientifique, France; May 1998; 12p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In order to improve the accuracy of numerical simulations applied to the new generation of high loaded, high-speed turbomachines, a thorough understanding of the 3D phenomena is needed. For that purpose, the use of 3D experimental techniques, like 3D-L2F anemometry, is now absolutely necessary. This paper deals with a statistical method for processing the data. The point is that, during the acquisition procedure, marginal and conditional probability density functions (p.d.f.) are obtained, but they are already integrated quantities. Hence, it becomes impossible to derive analytical relations between the p.d.f. and the 3D first and second order momenta. However, an issue can be found using an isotropic turbulence hypothesis. This method has been, first of all, tested in an axisymmetrical free jet. Furthermore, an experimental investigation of the three dimensional flow field within the tip area of a high loaded, low-speed axial compressor was performed.
Author
Three Dimensional Flow; Turbocompressors; Velocity Measurement; Laser Anemometers; Data Processing; Flow Velocity; Free Jets; Statistical Analysis

19980206013 Universitaet der Bundeswehr Muenchen, Inst. fuer Strahlantriebe, Neubiberg, Germany
LASER-2-FOCUS MEASUREMENTS ON A TURBINE CASCADE WITH LEADING EDGE FILM COOLING
Ardey, S., Universitaet der Bundeswehr Muenchen, Germany; Fottner, L., Universitaet der Bundeswehr Muenchen, Germany; Beversdorff, M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Weyer, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; May 1998; 12p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In order to increase the understanding of the aerodynamic processes dominating the flow field of turbine bladings with leading edge film cooling, isothermal investigations were carried out on a large scale high pressure turbine cascade. Close to the stagnation point the turbine cascade has one row of film cooling holes on the suction side and another one on the pressure side. Blowing ratio, turbulence intensity, Mach number, and Reynolds number are set to values typically found in modern gas turbines. Since a very sensitive flow pattern with high velocity gradients and reverse flow areas was to be expected near the blowing holes the Laser-2-Focus technique was selected for investigations in this area. Two independent systems were used: A standard two dimensional Laser-2-Focus system permanently installed in the wind tunnel and a temporarily set up three dimensional Laser-2-Focus system of the DLR-Institut fur Antriebstechnik, Koln. The results of the two systems are in good agreement. They indicate vortices in the exit plane of the film cooling holes developing into a flow pattern with upwinds directly behind the holes and downwinds further downstream. In the wake of the pressure side holes a large recirculation zone can be observed located below the coolant jet.
Author
Turbine Blades; Cascade Flow; Film Cooling; Optical Measuring Instruments; Aerodynamic Characteristics; Coolants; Leading Edges; Wind Tunnel Tests; Holes (Mechanics); Flow Measurement; Jet Flow

19980206017 Rolls-Royce Ltd., Applied Science Lab., Derby, United Kingdom
RECENT DEVELOPMENTS IN THE APPLICATION OF LASER DOPPLER ANEMOMETRY TO COMPRESSOR RIGS
Edmonds, Jonathan D., Rolls-Royce Ltd., UK; Harvey, David, Rolls-Royce Ltd., UK; Wiseall, Stephen S., Rolls-Royce Ltd., UK; May 1998;

10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A 3D Laser Doppler Anemometry (LDA) system capable of measuring comprehensive in rotor flowfields on high-speed compressor rigs has been developed by the Rolls-Royce Applied Science Laboratory. This paper describes the system and presents data from a recent compressor rig test.

Author

Laser Anemometers; Compressors; Test Stands; Velocity Measurement; Flow Velocity; Data Acquisition; Nonintrusive Measurement

19980206018 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Abteilung Windkanael, Goettingen, Germany

PSP: INTENSITY AND LIFETIME MEASUREMENTS FOR STEADY AND NONSTEADY FLOW

Engler, R. H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Klein, C., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

DLR started at 1995 with there own Pressure Sensitive-Paints (PSP) activities. A phase of extensive exploration of hard- and software-components followed and internal measurements using the intensity and lifetime method which includes spectra, calibration curves, etc. were performed. A repeatability study was made on the DASA HYTEX model, comparing the Inteco OPMS measurements from 1992/94 with the now existing DLR PSP system. Therefore, different lamps and laser illumination systems were tested. This included several cameras (intensified CCD and non-intensified CCD) for comparison of different paint samples in an external calibration chamber. After these pre-tests in the calibration chamber, measurements were performed in the Transonic Wind Tunnel Gottingen (TWG).

Author

Flow Measurement; Optical Measurement; Steady Flow; Paints; Life (Durability); Luminous Intensity; CCD Cameras; Wind Tunnel Tests; Pressure Measurement

19980206020 Purdue Univ., School of Aeronautics and Astronautics, West Lafayette, IN United States

ROTOR BLADE PRESSURE MEASUREMENT IN A ROTATING MACHINERY USING PRESSURE AND TEMPERATURE SENSITIVE PAINTS

Torgerson, S., Purdue Univ., USA; Liu, T., Purdue Univ., USA; Sullivan, J., Purdue Univ., USA; May 1998; 12p; In English; See also 19980206002; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Pressure and temperature sensitive paints have been utilized for the measurement of blade surface pressure and temperature distributions in a high speed axial compressor and an Allied Signal F109 gas turbine engine. Alternate blades were painted with temperature sensitive paints and then pressure sensitive paint. This combination allows temperature distributions to be accounted for when determining the blade suction surface pressure distribution. Measurements were taken and pressure maps on the suction surface of a blade were obtained over a range of rotational speeds. Pressure maps of the suction surface show-strong shock waves at the higher speeds.

Author

Gas Turbine Engines; Turbocompressors; Pressure Measurement; Paints; Pressure; Surface Temperature; Compressor Blades; Suction; Temperature Measurement

19980206021 Oxford Univ., Dept. of Engineering Science, Oxford, United Kingdom

USE OF LIQUID CRYSTAL TECHNIQUES TO MEASURE FILM COOLING HEAT TRANSFER AND EFFECTIVENESS

Guo, S. M., Oxford Univ., UK; Lai, C. C., Oxford Univ., UK; Jeong, J. H., Oxford Univ., UK; Jones, T. V., Oxford Univ., UK; Oldfield, M. L. G., Oxford Univ., UK; Lock, G. D., Bath Univ., UK; Rawlinson, A. J., Rolls-Royce Ltd., UK; May 1998; 18p; In English; See also 19980206002; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The transient liquid crystal technique has been used to measure the heat transfer coefficient and cooling effectiveness over heavily film cooled nozzle guide vanes (NGVs). The measurements were performed in the complex environment of a transonic annular cascade which simulates the flow in the gas turbine jet engine. Engine-representative Mach and Reynolds numbers were created and the aerodynamic and thermodynamic characteristics of the coolant flow (momentum flux and density ratio between the coolant and mainstream) have been modelled by using heavy foreign gases (SF6 /Ar mixture). The Red-Green-Blue (RGB) components have been separated from the colour response of wide-band encapsulated liquid crystals which react to changes of the NGV surface temperature during the transient experiment. Optical access to the test NGV was problematic and the thermochromic response of the crystals was sensitive to both the lighting and the wide range of viewing angles subtended at the camera. An in situ calibration is used to translate the RGB histories to measurements of the surface temperature history, and hence local heat transfer coefficient and adiabatic wall temperatures were obtained. The colour data has been gathered using a miniature CCD camera and recorded directly to computer memory without the use of video tape recorder. The transient liquid crystal technique is shown to be capable of accurately gathering data over any portion of the NGV surface visible to the camera used. As the data is collected in an environment which models the engine, the data is of benefit for both CFD code validation and directly to the engine designer.

Author

Liquid Crystals; Film Cooling; Heat Transfer; Guide Vanes; Cascade Flow; Annular Flow; Temperature Measurement; Surface Temperature; Coolants

19980206037 British Columbia Univ., Dept. of Mechanical Engineering, Vancouver, British Columbia Canada

MEASUREMENT OF UNSTEADY WAKE-BOUNDARY LAYER INTERACTION USING HOT FILMS

Gete, Zenebe, British Columbia Univ., Canada; Evans, R. L., British Columbia Univ., Canada; May 1998; 14p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Boundary layers developing on a surface subject to the intermittent passage of wakes, such as those on turbomachinery blading, are known to be highly unsteady. In this experimental study, a flat plate mounted in a wind tunnel downstream of a moving wake generator was used to model the wake-boundary layer interaction process in actual turbomachines. The boundary layer and the wall shear stress developing on the flat plate in this unsteady environment were measured using hot wire Anemometry and hot film sensors mounted on the plate surface. Measurements were taken at several locations downstream of the plate leading edge, and at several values of the reduced frequency. The results from the hot-film sensors showed that the unsteady boundary layer resulted in significantly higher losses in comparison to a steady boundary layer developing in the absence of passing wakes.

Author

Turbulent Boundary Layer; Wakes; Velocity Measurement; Wave Interaction; Turbomachinery; Flat Plates; Fluid-Solid Interactions; Wind Tunnel Tests; Shear Stress

19980206038 Technische Univ., Fachgebiet Gasturbinen und Flugantriebe, Darmstadt, Germany

MEASUREMENTS WITH SURFACE MOUNTED HOT-FILM SENSORS ON BOUNDARY LAYER TRANSITION IN WAKE DISTURBED FLOW

Haueisen, Volkmar, Technische Univ., Germany; Schroeder, Thomas, Technische Univ., Germany; Hennecke, Dietmar K., Technische Univ., Germany; May 1998; 14p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Boundary layer transition with and without transitional separation bubbles on a circular cylinder in crossflow was investigated. Measurements were carried out in undisturbed, steadily disturbed, and periodically disturbed flow. Besides the surface static pressure distribution and besides the measurement of velocity profiles with a hot-wire probe the investigations were focussed on the signal distributions of surface mounted hot-films. The reaction of separation and transition to changes of the Reynolds number or the degree of disturbance can be observed. In comparison with the hot-wire traverses, which were carried out in parallel with the hot-film measurements, the experiments show that the surface-mounted hot-film-technique is suitable to obtain reliable information on transition and separation phenomena with both high spatial and temporal resolution. Measurements with surface-

mounted hot-film sensors in a multistage aero-engine low-pressure turbine show that use of this technique is not only restricted to laboratory conditions but is as well suitable for complex geometry and engine condition.
Author
Boundary Layer Transition; Circular Cylinders; Cross Flow; Transition Flow; Turbines; Velocity Measurement; Wakes; Separated Flow; Hot-Film Anemometers; Static Pressure

19980206039 Virginia Polytechnic Inst. and State Univ., Blacksburg, VA United States
TIME RESOLVED MEASUREMENTS OF TURBINE BLADE FLOW PHENOMENA
Diller, T. E., Virginia Polytechnic Inst. and State Univ., USA; Ng, W. F., Virginia Polytechnic Inst. and State Univ., USA; Schetz, J. A., Virginia Polytechnic Inst. and State Univ., USA; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The facility and instrumentation are described for studying the effects of time-dependent flow phenomena. The components of unsteadiness from upstream rotor blades and the combustor of a gas turbine engine are modeled individually as shocks, wakes, and free-stream turbulence. The decomposition of the unsteadiness allows fundamental physical modeling of the effects on the flow structure and blade heat transfer. The strength and spacing of the shocks, the intensity and length-scale of the turbulence, and the wake velocity defect and turbulence can all be independently controlled. The blow-down facility provides 30 seconds of heated flow through a stationary blade cascade that matches the Reynolds number, Mach number, and temperature ratio characteristics of advanced gas turbine engines. Detailed observations are provided by spark shadowgraphs (10(exp -8) sec.), laser interferometry (10(exp -7) sec.) to obtain the instantaneous global density field, and surface pressure and heat flux measurements. The heat flux measurements have a time response of less than 10 micro-sec with a continuous voltage output. Because the sensors are less than 2 micro-m thick, they are non-intrusive to the flow and temperature fields. As one example of the capabilities, computer visualization from shadowgraphs of shock propagation through a blade passage with simultaneous surface pressure and heat flux measurements will be shown.
Author
Nonintrusive Measurement; Combustion Chambers; Turbine Blades; Wakes; Time Dependence; Flow Characteristics; Turbulence; Temperature Measurement; Pressure Measurement; Density Measurement; Shock Waves

19980206044 Defence and Evaluation Research Agency, Propulsion Dept., Pyestock, United Kingdom
PARTICLE IMAGE VELOCIMETRY MEASUREMENTS FROM THE STATOR-ROTOR INTERACTION REGION OF A HIGH PRESSURE TRANSONIC TURBINE STAGE AT THE DERA ISENTROPIC LIGHT PISTON FACILITY
Chana, K. S., Defence and Evaluation Research Agency, UK; Healey, N., Defence and Evaluation Research Agency, UK; Bryanston-Cross, P. J., Warwick Univ., UK; May 1998; 8p; In English; See also 19980206002; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In high pressure turbines the flow in the stator-rotor interaction region is highly complex with periodic and random unsteady effects generated as the stator wakes impinge on the rotor blades. Measuring the flow in this region is difficult with conventional instrumentation, further complicated in a short duration facility. This paper discusses the application of particle image velocimetry to this region of flow and, outlines the technological advances made recently to demonstrate the technique in the short duration Isentropic Light Piston Facility (ILPF) at DERA Pyestock. A series of measurements have been made in the stator passage and the stator-rotor gap region of the MTI high pressure turbine stage, in the ILPF. The measurements have been made at full engine-representative flow conditions and provide an instantaneous quantitative whole field visualisation of this unsteady flow region. The measured velocity field is compared with computational fluid dynamics (CFD) predictions obtained using a three-dimensional viscous flow solver. Theses measurements are thought to be the first to be made in a rotating transonic facility.
Author
Particle Image Velocimetry; Supersonic Turbines; Pressure Dependence; Velocity Measurement; Unsteady Flow; Rotor Stator Interactions

19980206045 Wright Lab., Aero Propulsion and Power Directorate, Wright-Patterson AFB, OH United States
THE UNSTEADY STRUCTURE OF SIMULATED TURBINE FILM COOLING FLOWS FROM PIV
Rivir, Richard B., Wright Lab., USA; Gogineni, Sivaram, Innovative Scientific Solutions, Inc., USA; Goss, Larry P., Innovative Scientific Solutions, Inc., USA; Pestian, David J., Dayton Univ. Research Inst., USA; May 1998; 14p; In English; See also 19980206002
Contract(s)/Grant(s): AF Proj. 2307; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Unsteady turbine film cooling flows are subjected to free stream disturbances which exceed those of a fully turbulent boundary layer. Hot wires, cold wires, and thermocouples have in the past been used to obtain local, time resolved point measurements of velocity, temperature, and mixing. The structure of the flow and its interaction with free stream structures remains largely hidden. Two-color, double pulsed, PIV (Particle Image Velocimetry) was used to investigate simulated turbine film-cooling flows with high free stream turbulence and wake passing. High resolution (3000 x 2000 pixels), instantaneous, velocity distributions obtained by CCD camera have been compared against those obtained from 35mm film digitized at 2700 ppi resulted in realizations with similar spatial resolution. Averages of 1 to 30 instantaneous PIV velocity measurements have been compared against simulated turbine film cooling flow velocity profiles measured by hot wire. The resulting PIV velocity profile measurements were mostly within the envelope of the mean and rms velocity measurements of the hot wire. The PIV images allow instantaneous estimates of the shear layer development, vertical cooling jet film spread, turning, and interactions with the free stream turbulence. Instantaneous vorticity, and dissipation distributions have also been obtained. The lateral jet spread of the film at the wall was measured with liquid crystals and thermocouples and compared with the vertical PIV spread. The centerline vertical film jet spread, turning angle, and shear layer growth has been characterized from the PIV realizations as a function of blowing ratio, Reynolds number, periodic forcing amplitude, frequency, and free stream turbulence.
Author
Film Cooling; Particle Image Velocimetry; Flow Velocity; Temperature Measurement; Velocity Measurement; Unsteady Flow; Turbulence; Wakes; Turbines

19980206048 Systelligence Consultants and Research Associates, Volos, Greece
RECENT PROGRESS IN WHOLE-FIELD NON-INTRUSIVE MEASUREMENTS OF 3-D VELOCITY VECTORS AND PARTICLE SIZE
Moraitis, C. S., Systelligence Consultants and Research Associates, Greece; Tisserant, D., Von Karman Inst. for Fluid Dynamics, Belgium; Breugelmans, F. A. E., Von Karman Inst. for Fluid Dynamics, Belgium; May 1998; 8p; In English; See also 19980206002
Contract(s)/Grant(s): CEC-MATI-CT93-0033; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Recent success in the implementation of particle image velocimetry (PIV) as a useful two-dimensional technique has encouraged efforts to develop three-dimension nonintrusive methods Holography appears to be a suitable technique to image three-dimensional flows seeded with small particles. A novel technique to process double or multiple exposure holograms has been developed during the last four years. Information about velocity and particle size is obtained by using an optical/digital processing technique. The interference pattern due to light-waves emanating from particles images is imaged and then processed digitally. Applicability of the concept is first demonstrated by processing a double-exposed hologram of a synthetic particles field submitted to a known displacement. For different ratios between the depth (out-of-plane) displacement component and the lateral (in-plane) one, results are discussed. They show that the accuracy is strongly related to the choice of the digital processing parameters, especially the number of fringes which are contained in the interfer-

ence pattern. Additional benchmarking of the technique has been carried out by applying it to a real flow of which velocity and direction are well known. Therefore, a jet flow facility with adjustable yaw and pitch angle has been designed. Various flow configurations have been investigated. At present state of work, processing result have to be improved. The diffraction halo of the particle images is so small that a limited number of fringes are available at the output of the optical processing part. Thus results of the digital processing algorithm are affected by a large uncertainty.
Author
Particle Image Velocimetry; Nonintrusive Measurement; Three Dimensional Flow; Velocity Measurement; Holography; Flow Velocity; Imaging Techniques; Jet Flow

19980206050 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. for Propulsion Technologie, Cologne, Germany
APPLICATIONS OF THREE DIMENSIONAL DOPPLER GLOBAL VELOCIMETRY TO TURBO MACHINERY AND WIND TUNNEL FLOWS
Roehle, I., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Schodl, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; May 1998; 14p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Doppler Global Velocimetry is an imaging anemometer. A DGV system optimised for time averaged three component velocity measurements was designed and set up. The first application of the system was the investigation of the flow field of a swirl spray nozzle in a cylindrical casing. The flow field in the whole volume of the combustor was measured. The DGV System was also applied to investigate the wake region of a car model in a wind tunnel. An arrangement with three light sheets was chosen. The 3D-DGV results are in a good agreement with 3D-LDA measurements of the same flow. 3D-DGV measurements were carried out inside the model of the inlet of a fighter aircraft. A flexible endoscope was used to overcome the serious problems of the optical excess of this fully capsuled flow.
Author
Laser Doppler Velocimeters; Flow Characteristics; Flow Velocity; Velocity Measurement; Wind Tunnels; Turbomachinery; Equipment Specifications; Imaging Techniques

19980210684 Office National d'Etudes et de Recherches Aerospatiales, Cheminh de la Huniere et des Joncherettes, Palaiseau, France
NOSTRAMARINE: A CONCEPT OF MULTISTATIC DETECTION ADJUSTED TO SURVEILLANCE OF LOW ALTITUDE TARGETS ***NOSTRAMARINE: UN CONCEPT DE DETECTION MULTISTATIQUE ADAPTE A LA SURVEILLANCE DES CIBLES BASSE ALTITUDE***
Lesturgie, M., Office National d'Etudes et de Recherches Aerospatiales, France; Flecheux, M., Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1998; 11p; In French; See also 19980210650; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper describes a new concept of over-the-horizon detection adjusted to surveillance of low altitude targets. The radar unit, in bistatic configuration, consists of a receiving system installed in the vicinity of the area to be monitored, and of a distant emitter, located behind the zone to be monitored. Overall functioning of the radar unit relies on combination of an 'ionospheric' propagation mode and a 'surface wave' propagation mode. Thus, because of the properties of reflection of electromagnetic waves in the ionosphere, the low altitude targets can be illuminated by the distant emitter, which will function at high frequencies. The electromagnetic waves, following interaction with the targets, will propagate by following the curvature of the earth (by 'surface waves') up to the receiving network. This concept comprises an alternative to the over-the-horizon radar by traditional surface waves (OTH-S), by placing in the geographic area to be monitored, the advantage of a passive and discrete device, which is provided with important integration capabilities.
Author
Ionospheric Propagation; Surveillance; Propagation Modes; Over-The-Horizon Radar; Electromagnetic Radiation; Earth Surface

19990024917 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
HYPERSONIC EXPERIMENTAL AND COMPUTATIONAL CAPABILITY, IMPROVEMENT AND VALIDATION, VOLUME 2 ***L'HYPERSONIQUE EXPERIMENTALE ET DE CALCUL: CAPACITE, AMELIORATION ET VALIDATION, VOLUME 2***
Muylaert, Jean, Editor, European Space Agency. European Space Research and Technology Center, ESTEC, Netherlands; Kumar, Ajay, Editor, NASA Langley Research Center, USA; Dujarric, Christian, Editor, European Space Agency, France; December 1998; 172p; In English; See also 19990024918 through 19990024923
Report No.(s): AGARD-AR-319-Vol-2; ISBN 92-836-1078-4; Copyright Waived; Avail: CASI; A08, Hardcopy; A02, Microfiche

The results of the phase 2 effort conducted under AGARD Working Group 18 on Hypersonic Experimental and Computational Capability, Improvement and Validation are presented in this report. The first volume, published in May 1996, mainly focused on the design methodology, plans and some initial results of experiments that had been conducted to serve as validation benchmarks. The current volume presents the detailed experimental and computational data base developed during this effort.
Author
Data Bases; Hypersonic Flow; Computational Fluid Dynamics; Research Projects; Wind Tunnel Tests; Real Gases; Hypersonic Vehicles

19990024918 Rutgers - The State Univ., Dept. of Mechanical and Aerospace Engineering, Piscataway, NJ United States
SHOCK WAVE BOUNDARY LAYER INTERACTIONS IN HIGH MACH NUMBER FLOWS: A CRITICAL SURVEY OF CURRENT NUMERICAL PREDICTION CAPABILITIES
Knight, Doyle D., Rutgers - The State Univ., USA; Degrez, Gerard, Von Karman Inst. for Fluid Dynamics, Belgium; Hypersonic Experimental and Computational Capability, Improvement and Validation; December 1998; Volume 2; 35p; In English; See also 19990024917
Contract(s)/Grant(s): F49620-93-1-0005; RFBR-96-01-01777; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The report assesses the capability for numerical simulation of 2-D and 3-D shock wave laminar and turbulent boundary layer interactions Three fundamental configurations are considered: single fin, double fin, and hollow cylinder flare. Thirteen separate cases were examined by a distinguished international group of researchers using the Reynolds-averaged Navier-Stokes (RANS) equations with a wide range of turbulence models from zero equation to full Reynolds Stress Equation formulations. The report presents an extensive comparison of computations and experimental data, summarizes the results, and makes recommendations for future research.
Author
Fins; Laminar Boundary Layer; Mach Number; Navier-Stokes Equation; Reynolds Averaging; Reynolds Equation; Turbulence Models; Turbulent Boundary Layer; Computational Fluid Dynamics; Flared Bodies; Shock Waves

19990024919 Arizona State Univ., Dept. of Mechanical and Aerospace Engineering, Tempe, AZ United States
HYPERSONIC LAMINAR-TURBULENT TRANSITION
Saric, William S., Arizona State Univ., USA; Reshotko, Eli, Case Western Reserve Univ., USA; Arnal, Daniel, Centre d'Etudes et de Recherches, France; Hypersonic Experimental and Computational Capability, Improvement and Validation; December 1998; Volume 2; 27p; In English; See also 19990024917; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The computational and experimental progress covering the four basic instability mechanisms that contribute to laminar-turbulent transition is reviewed. Streamwise, crossflow, centrifugal, and attachment-line instabilities and their principal means for initiating transition in hypersonic boundary layers are discussed. Comparisons between computations and experiments are given. Issues relating to how free-stream disturbances influence the initial amplitudes of disturbances are also documented. Particular attention is paid to prediction schemes based on linear theory although other techniques are

reviewed. This discussion is used to review the capabilities of present and future transition prediction methods as well as flow-quality requirements for hypersonic experimental facilities.
Author
Boundary Layer Transition; Hypersonic Boundary Layer; Laminar Flow; Research Facilities; Turbulent Boundary Layer; Reynolds Number; Navier-Stokes Equation; Computational Fluid Dynamics; Compressible Flow; Wind Tunnel Tests; Hypersonic Flow

19990024920 NASA Langley Research Center, Hampton, VA United States
RAREFIED FLOW
Moss, James N., NASA Langley Research Center, USA; Lengrand, Jean-Claude, Centre National de la Recherche Scientifique, France; Hypersonic Experimental and Computational Capability, Improvement and Validation; December 1998; Volume 2; 28p; In English; See also 19990024917; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Rarefaction effects are important for hypersonic applications for a wide spectrum of conditions ranging from low-density (high altitude) situations to relatively high-density flows where the characteristic dimension is small. The present chapter concentrates on two hypersonic flow problems at flow conditions that produce a significant range of rarefaction effects: corner flow with jet interaction and blunt body flow with special emphasis on the near wake, These problems were chosen because they involve complex flow interactions that have significant implications for both spacecraft and re-entry vehicles. In an effort to clarify issues associated with these two general flow problems and to enhance their respective databases, both experimental and computational contributions were executed by an international group of researchers. In some cases, multiple data sources for both experimental and computational contributions are achieved.
Derived from text
Blunt Bodies; Corner Flow; High Altitude; Hypersonic Flow; Rarefaction; Aerospace Vehicles; Wind Tunnel Tests; Navier-Stokes Equation; Computational Fluid Dynamics

19990024921 NASA Ames Research Center, Moffett Field, CA United States
REAL GAS/BLUNT CONE, PHASE 2
Deiwert, George S., NASA Ames Research Center, USA; Eitelberg, Georg, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Hypersonic Experimental and Computational Capability, Improvement and Validation; December 1998; Volume 2; 21p; In English; See also 19990024917; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

In this chapter recent activity in real-gas database definition and code validation will be summarized. In the Phase I report of the Working Group (WG) 181, aerothermodynamic problems were classified, for purpose of discussion, into seven types: aerodynamic parameters, viscous/shock interaction, boundary-layer transition, forebody-heating/heat-transfer, radiation and ablation, lee and base-region flow, and low-density flow. Several of these problem types were the subject of various chapters of the Phase 1 report describing real-gas effects and ground test facility issues. In this chapter some background and objectives outlined in the real-Gas effects Chapter V of the Phase 1 report will be reviewed. The results of the blunt cone test campaign developed under the auspices of the WG18 activity to study real-gas phenomena will be summarized, including the experimental and computational programs, issues and questions, and recommendations. Further, recent progress in other real-gas areas beyond the blunt cone test campaign will be discussed. Finally, a summary in which the present status of our understanding of real-gas issues will be presented.
Derived from text
Aerothermodynamics; Heat Transfer; Real Gases; Computational Fluid Dynamics; Hypersonic Flow; Blunt Bodies; Cones; Enthalpy; Nitrogen; Navier-Stokes Equation; Oxygen; Wind Tunnel Tests

35
INSTRUMENTATION AND PHOTOGRAPHY

19950025708 Defence Research Establishment Valcartier, Courcellette Quebec, Canada
INFRARED AND MILLIMETER WAVE DETECTION USING THIN FILMS OF PB DOPED BISRCACUO SUPERCONDUCTOR
Phong, L. Ngo, Defence Research Establishment Valcartier, Canada; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 10 p; In English; See also 19950025702; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Thin film detectors made of CuO superconductors were developed in our laboratory. This article reports details of the fabrication and testing of Pb doped BiSRCaCuO detectors. The detector comprises a film sensor housed in a small cryostat with built-in bias supply and temperature control circuitry. The film sensor was first deposited by magnetron rf sputtering and then crystallized under a rapid thermal annealing process. The characteristics of the response of the detector under millimeter wave and infrared illumination were investigated. The millimeter wave response exhibited a Josephson component with a D(*) approximately 10(exp 8) - 10(exp 9) cm.Hz(exp (1/2))/W in the wavelength range of 3 - 8 mm. The transient response to short pulses indicated a time constant tau less than or equal to 10 ns for this component. The response to laser pulses was thermal in origin and inherently compressible, preventing saturation of the detector electronics to intense beams. The wide band characteristic of the responses at both infrared and millimeter wavelengths could be confirmed. The damage threshold of the film sensor was shown to exceed 10 mJ / sq cm per 3 ns pulse. The possible use of these detectors for threat detection and the optimization of their figure of merit are discussed.
Author
Broadband; BSCCO Superconductors; Doped Crystals; Infrared Detectors; Infrared Radiation; Infrared Spectra; Lead (Metal); Millimeter Waves; Pulse Duration; Pulsed Lasers; Thin Films; Weapon Systems

19950025713 Office National d'Etudes et de Recherches Aeronautiques, Ingenieurs de Recherche., Paris, France
DESIGN OF SURVEILLANCE AND MULTISENSOR ANTI-AERIAL SYSTEMS *CONCEPTION DE SYSTEMES DE SURVEILLANCE ET DE DEFENSE ANTI-AERIENNE MULTI-SENSEURS*
Nahum, C., Office National d'Etudes et de Recherches Aeronautiques, France; Cantalloube, H., Office National d'Etudes et de Recherches Aeronautiques, France; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 9 p; In French; See also 19950025702; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Software ROSACE (Optimization of Realistic Systems, Contributes to the Design and the Evaluation), is developed within the framework of the study methodology of multisensors for anti-aircraft defense and is financed by the DRET (contract n 91-34-846). This document concerns a interactive tool, that is evolutionary, portable and of assistance to the definition, the qualification, and the optimization of multisensor systems for anti-aircraft monitoring and defense. This product constitutes a support for the expertise and search for new treatments which utilize the fusion of information and are likely to improve the performance of the system. These algorithms primarily ensure (but not exclusively) the tasks of detection and continuation or classification of air machines and make it possible to analyze the reliability of the system confronted with different scenarios.
CASI
Antimissile Defense; Computer Systems Design; Multisensor Applications; Remote Sensing; Surveillance; Warfare; Weapon Systems

19950026708 Delphin Central Research Inst., Moscow, Russia
COMMERCIAL USAGE OF NAVY COMPONENTS DEVELOPED AND MANUFACTURED BY CRI DELFIN
Novgorodski, A. V., Delphin Central Research Inst., Russia; Chichinadze, M. V., Delphin Central Research Inst., Russia; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 9 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Parameters of gyro systems (accuracy, size, power consumption, reliability, etc.) are determined by parameters of the elements of

which the gyro unit consists. The elements developed for military equipment meet the utmost requirements. Over the past ten years the 'Delphin' Central Research Institute developed a whole number of elements including a gyro, an accelerometer, a torquer, a slip-ring assembly, etc. to provide a basis for designing gyro systems for military purposes. The conversion made it possible to use these elements in commercial gyro systems. The present paper deals with such elements and systems created on their basis and used for commercial purposes.
Derived from text
Accelerometers; Commerce; Gyroscopes; Navy; Technology Transfer; Technology Utilization; Torquers

19950026709 Saint Petersburg State Electrotechnical Univ., Saint Petersburg, Russia
SOME RESULTS OF INTERNATIONAL COOPERATION IN MILITARY TO COMMERCIAL CONVERSION OF LASER GYRO TECHNOLOGY
Filatov, Yu. V., Saint Petersburg State Electrotechnical Univ., Russia; Loukianov, D. P., Saint Petersburg State Electrotechnical Univ., Russia; Mochalov, A. V., Saint Petersburg State Electrotechnical Univ., Russia; Probst, R., Physikalisch-Technische Bundesanstalt, Germany; Rodloff, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Stieler, B., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 5 p; In English; See also 19950026705; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The results of military to commercial conversion in the field of laser gyro technology are considered. Laser gyro systems were developed in Russia for military purposes. After some modifications within an international cooperation they are used nowadays also for civil applications as track surveying, deformation measurements of long objects and precision angle and angular rate measurements and angle calibration.
Derived from text
Commerce; International Cooperation; Laser Applications; Laser Gyroscopes; Military Operations; Technology Transfer; Technology Utilization

19950026711 Draper (Charles Stark) Lab., Inc., Cambridge, MA, United States
DUAL-USE MICROMECHANICAL INERTIAL SENSORS
Elwell, John M., Jr., Draper (Charles Stark) Lab., Inc., USA; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 6 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

A new industry, which will provide low-cost silicon-based inertial sensors to the commercial and military markets. is being created. Inertial measurement units are used extensively in military systems, and new versions are expected to find their way into commercial products, such as automobiles, as production costs fall as technology advances. An automotive inertial measurement unit can be expected to perform a complete range of control, diagnostic, and navigation functions. These functions are expected to provide significant active safety, performance, comfort, convenience, and fuel economy advantages to the automotive consumer. An inertial measurement unit applicable to the automobile industry would meet many of the performance requirements for the military in important areas, such as antenna and image stabilization, autopilot control, and the guidance of smart weapons. Such a new industrial base will significantly reduce the acquisition cost of many future tactical weapons systems. An alliance, consisting of the Charles Stark Draper Laboratory and Rockwell International, has been created to develop inertial products for this new industry.
Derived from text
Accelerometers; Guidance Sensors; Gyroscopes; Inertial Navigation; Micromechanics; Silicon; Technology Assessment; Technology Transfer; Technology Utilization

19950026712 Scientific Research Inst. of Mechanical Problems, Kiev, Ukraine
LASER GYROSCOPY TENDENCIES AND THEIR ANALYSIS OF DEVELOPMENT IN UKRAINE
Dovbeshko, Alexander A., Scientific Research Inst. of Mechanical Problems, Ukraine; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 11 p; In English; See also 19950026705; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

These papers deal with the theoretical and experimental data analysis approach of the accuracy and characteristics of laser gyroscopes obtained by Ukrainian firms. A theoretical model concerned with the physical phenomena of a ring laser with a 4-mirror resonator is created. Ring lasers are considered continuous, nonlinear self-excited oscillatory systems, that contain a number of limited and spatial nonuniform elements (active medium, diaphragms, mirrors). A model of laser generation that considers the effect of more than 40 resonator and amplifying medium parameters on laser output characteristics (intensity, frequencies difference, locking zone, etc.) was created. The mechanism that determines the mode selection and backscattering light from mirrors and diaphragms influence on the intensity and frequency difference of a traveling-wave in a ring laser is investigated. The mode formation mechanism (caustic or guide, or guide-caustic type) that depends on the resonator type and mirrors' dimension, radius of curvature and the channel shape and its linear dimensions can be achieved with the laser. It is shown, that the connection of the counter waves has a diffractional as well as a interferentional nature and is defined by the parameters of the resonator mirrors and diaphragms as well as by their disposition as to the amplifying medium. Using the latter,the methods and the devices that allow the decrease of the influence of the static zone of the waves lock on the output characteristics in 10-20 times has been created. Proceeding from the created mathematical model, the methods of optimization element composition and parameters of optical-physical scheme of the ring laser and the systems of stabilization and control of the laser generation regime of the laser gyroscope are worked out. The microprocessor systems for the laser gyroscope generation regime support and stabilization of its parameters during experimentation were completed. It is shown experimentally that laser gyroscope with such systems has a null drift 0.005 degree/hour and a random walk 0.003 degree/sq rt (hour).
Derived from text
Laser Applications; Laser Gyroscopes; Laser Mode Locking; Laser Outputs; Mirrors; Nonlinear Systems; Resonators; Ring Lasers; Technology Assessment; Technology Utilization; Ukraine

19950026722 SPEEL Ltd., Prague, Czechoslovakia
SOLID-STATE DATA RECORDER, NEXT DEVELOPMENT AND USE
Vidiecan, J., SPEEL Ltd., Czechoslovakia; Kozak, J., SPEEL Ltd., Czechoslovakia; Horak, K., SPEEL Ltd., Czechoslovakia; Svoboda, J., SPEEL Ltd., Czechoslovakia; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 10 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

The use of data recorders on-board aircraft for crash and later for maintenance and logistic purposes is well known. Due to higher requirements for safety and economy of ground transport vehicles operation, such devices are already used in selected types of these vehicles. The use of new technology - solid-state memories - enables the increase of technical parameters of such recorders (number of registered parameters, MTBF), reduces the mass, space and requirements on technical assistance during operation. In this paper a technical description of such recorders for aircraft and ground based vehicles is given. Also, results of recent applications of these devices and different methods and software for evaluation are also presented.
Derived from text
Data Recorders; Electronic Equipment; Installing; Solid State; Tachometers; Technological Forecasting; Technology Utilization; Transport Vehicles

19960003867 Defence Research Establishment Ottawa, Ottawa Ontario, Canada
DESIGN, CONSTRUCTION AND CALIBRATION OF SENSORS FOR HPM MEASUREMENTS
Seregelyi, J. S., Defence Research Establishment Ottawa, Canada; Kashyap, S., Defence Research Establishment Ottawa, Canada; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 11 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The measurement of High Power Microwave (HPM) coupling is an important diagnostic tool in the understanding of HPM interaction with complex structures. The quantities of interest include the electric and magnetic fields both in free space and at (or near) the surface of

a body. The sensors used must be small in order to cause minimal perturbation of the ambient field and to function over as wide a bandwidth as possible. In addition, the signal-to-noise ratio (SNR) must be as large as possible. This paper presents an engineering overview of the design and construction of various HPM sensors presently used at the Defence Research Establishment (DREO). Calibration methods for such sensors will also be briefly discussed.
Author
Calibrating; Construction; Electric Fields; Magnetic Fields; Microwave Coupling; Microwave Sensors

19960022252 Institut de Recherche en Communications Optique et Micro-onde, Limoges, France
MICROWAVE SENSORS FOR MATERIAL CHARACTERIZATION
Caille, A., Institut de Recherche en Communications Optique et Micro-onde, France; Derray, D., Institut de Recherche en Communications Optique et Micro-onde, France; Julien-Vergonjanne, A., Institut de Recherche en Communications Optique et Micro-onde, France; Guillon, P., Institut de Recherche en Communications Optique et Micro-onde, France; Environmental Factors in Electronic Warfare Related to Aerospace Systems; Jan. 1996; 12p; In English; See also 19960022241; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Two sensors for a non-destructive testing of materials at low microwave frequencies are described. One is a resonant dielectric probe acting on a quasi-TEM mode at about 1.7 GHz. The other sensor is a microstrip system developed in the 0.5-2.5 GHz frequency range. The Finite Element Method (FEM) leads to the determination of resonant or propagation parameters of each sensor. The main basis of characterization methods is to compare the measurement values of the characteristic parameters of the sensors with the corresponding theoretical ones. Several tests of dielectric and magnetic materials are presented and confirm the validity of the two methods.
Author
Microwave Sensors; Nondestructive Tests; Finite Element Method; Magnetic Materials

19980203987 NASA Langley Research Center, Hampton, VA United States
ADVANCED MEASUREMENT TECHNOLOGY AT NASA LANGLEY RESEARCH CENTER
Antcliff, Richard R., NASA Langley Research Center, USA; May 1998; 12p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Instrumentation systems have always been essential components of world class wind tunnels and laboratories. Langley continues to be on the forefront of the development of advanced systems for aerospace applications. This paper will describe recent advances in selected measurement systems which have had significant impact on aerospace testing. to fully understand the aerodynamics and aerothermodynamics influencing aerospace vehicles, highly accurate and repeatable measurements need to be made of critical phenomena. However, to maintain leadership in a highly competitive world market, productivity enhancement and the development of new capabilities must also be addressed aggressively. The accomplishment of these sometimes conflicting requirements has been the challenge of advanced measurement developers. However, several new technologies have recently matured to the point where they have enabled the achievement of these goals. One of the critical areas where advanced measurement systems are required is flow field velocity measurements. These measurements are required to correctly characterize the flowfield under study, to quantify the aerodynamic performance of test articles and to assess the effect of aerodynamic vehicles on their environment. Advanced measurement systems are also making great strides in obtaining planar measurements of other important thermodynamic quantities, including species concentration, temperature, pressure and the speed of sound. Langley has been on the forefront of applying these technologies to practical wind tunnel environments. New capabilities in Projection Moire Interferometry and Acoustics Array Measurement systems have extended our capabilities into the model deformation, vibration and noise measurement arenas. An overview of the status of these techniques and recent applications in practical environments will be presented in this paper.
Author
Aerospace Engineering; Aerodynamics; Aerospace Vehicles; Aerothermodynamics; Wind Tunnels; Thermodynamics; Flow Distribution; Mechanical Measurement

19980204004 MetroLaser, Irvine, CA United States
ADVANCES IN AERODYNAMIC HOLOGRAPHY
Trolinger, James D., MetroLaser, USA; Millerd, James, MetroLaser, USA; Weber, David, MetroLaser, USA; Brown, Michael, MetroLaser, USA; May 1998; 18p; In English; See also 19980203985
Contract(s)/Grant(s): F33615-96-C-2656; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Researchers continue to find new ways to employ holography to measure aerodynamic parameters in almost all flow regimes. Since holography provides a method to store optical wavefronts in such a fashion as to allow their reconstruction and analysis at a later time, it is a natural intermediate step for many conventional optical diagnostic procedures that employ interferometry, schlieren, deflectometry, particle image velocimetry, and three-dimensional visualization. For example, optical wavefronts representing one condition of a flow can be interfered directly with those representing a second condition, simply by storing the wavefronts holographically, providing at the same time a simple mechanism to subtract out all non varying conditions (such as optical defects). The result is a powerful method for the study of turbulent flow. These procedures have now been in use for many years and are reaching maturity, but the field is by no means stagnant. More recently, holographic techniques have been extended to include multiple wavelength recording holography at a wavelength tuned to include a resonance of a constituent in the flow, real-time holography (four wave mixing), and recording in photorefractive materials, SLM's, and CCD's. Also, new ways of using holograms to record, reconstruct and produce unique wavefronts for measurement have evolved. For example, holograms can be placed directly on a model surface to aid in measurement (optically smart surfaces). In resonance interferometry, sensitivity is enhanced by tuning the light to the resonance line of a substance, exploiting the large refractive index change caused by anomalous dispersion at resonance. Holography enhances this unique form of interferometry by allowing useful interference between two beams (of different wavelength) that pass through exactly the same paths at the same time. This further allows interferograms to be recorded in photorefractive materials in such a way that a cineholographic interferometry movie of the selected substance in the field of interest can be recorded. Four wave mixing (sometimes called real-time holography) provides a unique way to measure temperature in high pressure flows, where other optical methods usually fail. This paper will describe the principles behind holographic flow diagnostics with emphasis on the more recently developed methods, and will consider the future potential of holographic diagnostics in aerodynamics.
Author
Aerodynamics; Holographic Interferometry; Particle Image Velocimetry; Four-Wave Mixing

19980204017 Technische Univ., Darmstadt, Germany
THE STATUS OF INTERNAL STRAIN GAGE BALANCE DEVELOPMENT FOR CONVENTIONAL AND FOR CRYOGENIC WIND TUNNELS
Ewald, B., Technische Univ., Germany; May 1998; 10p; In English; See also 19980203985; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The measurement of the aerodynamic forces is still the most important task in the wind tunnel at least for aircraft development work. Accuracy and reliability of the balance are key factors in this test technology. The urgent requirement for more and more accurate force testing leads to a demand for more and more balance accuracy. The most urgent demand in this field comes from the Cryogenic Tunnels like the NTF and the new European Wind Tunnel. The outcome of effort at the Darmstadt University of Technology is not only a cryogenic balance technology, which allows transport performance measurements in the ETW with a repeatability of less than one drag count with variable tunnel temperature but also a considerable improvement of balances for conventional tunnels. For this result all aspects of the balance technology had to be treated. For the balance design a

computerized method was developed, which allows an optimization of the structural design in a short time. Principal aspects of the design were studied with Finite Element analysis for optimized solutions. The technique of the electron beam welded balance was established successfully. This construction method gives considerable advantages with respect to design for optimum structure stiffness and low interference. The difficult problem of strain gaging and wiring for cryogenic environment with severe moisture conditions was solved as a result of lengthy efforts. For cryogenic balances a novel axial force measurement system was developed, which solves the problem of temperature gradient induced error signals. For residual errors of this type numerical correction methods are proven. u For balance calibration a new strategy is used. A novel mathematical algorithm extracts a third order measuring matrix (no matrix inversion necessary) from the calibration data set. In a mathematical sense this is the best possible closed solution. In cooperation with Deutsche Airbus and the Carl Schenck Company a fully automatic calibration machine was developed for ETW. A smaller and simplified version of this machine is under construction at the Darmstadt University of Technology. Finite element analysis turned out to be a powerful tool in the development of optimized balance structures. Novel balance structures with minimized linear and non-linear interference and with minimized sensitivity against temperature gradients have been developed. For half model testing, which is a more and more important technique in transport development, compact half model balances have been developed and constructed. The crucial problem of temperature sensitivity of such balances was successfully solved by FEM optimization.
Author
Cryogenic Wind Tunnels; Wind Tunnel Apparatus; Strain Gage Balances; Finite Element Method; Aerodynamic Forces; Aircraft Design

19980204018 NASA Langley Research Center, Hampton, VA United States
SUMMARY REPORT OF THE FIRST INTERNATIONAL SYMPOSIUM ON STRAIN GAUGE BALANCES AND WORKSHOP ON AOA/MODEL DEFORMATION MEASUREMENT TECHNIQUES
Tripp, John S., NASA Langley Research Center, USA; Tcheng, Ping, NASA Langley Research Center, USA; Burner, Alpheus W., NASA Langley Research Center, USA; Finley, Tom D., NASA Langley Research Center, USA; May 1998; 12p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The first International Symposium on Strain Gauge Balances was sponsored under the auspices of the NASA Langley Research Center (LaRC), Hampton, Virginia. Held at the LaRC Reid Conference Center, the Symposium provided an open international forum for presentation, discussion, and exchange of technical information among wind tunnel test technique specialists and strain gauge balance designers. The Symposium also served to initiate organized professional activities among the participating and relevant international technical communities. The program included a panel discussion, technical paper sessions, tours of local facilities, and vendor exhibits. Over 130 delegates were in attendance from 15 countries. A steering committee was formed to plan a second international balance symposium tentatively scheduled to be hosted in the United Kingdom in 1998 or 1999. The Balance Symposium was followed bv the halfday, Workshop on Angle of Attack and Model Deformation on the afternoon of October 25. The thrust of the Workshop was to assess the state of the art in angle of attack (AoA) and model deformation measurement techniques and to discuss future developments.
Author
Strain Gage Balances; Wind Tunnel Tests; Pressure Measurement; Density Measurement

19980206009 Institute for Aerospace Research, Combustion Research Group, Ottawa, Ontario Canada
NON-INTRUSIVE MEASUREMENT TECHNIQUE FOR PROPULSION ENGINES
Mulligan, M. F., Institute for Aerospace Research, Canada; MacLeod, J. D., Institute for Aerospace Research, Canada; May 1998; 12p; In English; See also 19980206002; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

With financial contributions from the Canadian Department of National Defence, the Structures, Materials, and Propulsion Laboratory of the National Research Council of Canada (NRC) established a program for evaluating the effects of component deterioration on gas turbine engine performance. The effort was aimed at investigating the performance changes resulting from typical in-service faults. An important aspect of the engine test program was the use of non-intrusive sensors to supplement conventional instrumentation. Combined gas and metal thermal patterns in the infrared radiation spectra, recorded using infrared thermography, were used to evaluate gas path patterns to identify possible fault conditions. Exhaust plane thermal patterns can be classified as "healthy" for no-fault conditions, and "distressed" where known faults are in existence. Several defective engine components, including fuel nozzles, combustor cans, turbine nozzles, and thermocouple probes were used to evaluate the effectiveness of this technique on an engine test bed. This paper covers the project objectives, the experimental installation, and the results of the tests. Descriptions of the infrared thermography system, the data reduction and analysis methodology are also included.
Author
Nonintrusive Measurement; Infrared Instruments; Thermography; Engine Tests; Engine Parts; Gas Turbine Engines; Nondestructive Tests; Temperature Measurement

19980206022 Rolls-Royce Ltd., Commercial Aero Engines, Derby, United Kingdom
SURFACE TEMPERATURE MEASUREMENT IN TURBINES
Bird, C., Rolls-Royce Ltd., UK; Mutton, J. E., Rolls-Royce Ltd., UK; Shepherd, R., Rolls-Royce Ltd., UK; Smith, M. D. W., Rolls-Royce Ltd., UK; Watson, H. M. L., Rolls-Royce Ltd., UK; May 1998; 10p; In English; See also 19980206002; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper reports on some of the turbine surface temperature measurement techniques and instrumentation currently in use and under development in Rolls-Royce. Firstly, thermal paints are reviewed highlighting the development of new computer aided analysis and interpretation techniques. Thin film thermocouples are described with their applicability to gas turbine engine components, especially those with thin skins. Finally, the novel technique of photoluminescence thermometry using so-called "thermographic phosphors" is described. Examples of measurements on static engine components and developments for measurements on rotating turbine blades are given.
Author
Temperature Measurement; Paints; Surface Temperature; Photoluminescence; Thermocouples; Temperature Measuring Instruments; Turbines

19980206030 Wright Lab., Aero Propulsion and Power Directorate, Wright-Patterson AFB, OH United States
MEETING THE ADVANCED INSTRUMENTATION THE NEEDS OF THE INTEGRATED HIGH PERFORMANCE TURBINE ENGINE TECHNOLOGY AND HIGH CYCLE FATIGUE PROGRAMS
Strange, William A., Wright Lab., USA; May 1998; 8p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper presents an overview of current research efforts aimed at improving turbine engine structural instrumentation capabilities. Emphasis is placed on nonintrusive concepts which will be applicable to the advanced engines currently in use, or being designed for initial operational testing shortly after the turn of the century. Technologies to be described include; blade tip deflection sensors to determine dynamic stress, thermographic phosphors to measure metal temperature, pressure sensitive paints and air etalons to measure dynamic pressure, and micro electro mechanical systems to assess a variety of parameters. Advantages of the various systems, potential problems and limitations, as well as, an assessment as to their applicability to either the Integrated High Performance Turbine Engine Technology or the High Cycle Fatigue initiative is discussed.
Author
Measuring Instruments; Nonintrusive Measurement; Engine Parts; Temperature Measurement; Stress Measurement; Dynamic Pressure; Pressure Measurement; Surface Temperature

19980206040 Rhode Island Univ., Dept. of Chemical Engineering, Kingston, RI United States
OVERCOATS FOR THE IMPROVED PERFORMANCE OF PDCR HIGH TEMPERATURE THIN FILM STRAIN GAGES
Gregory, Otto J., Rhode Island Univ., USA; Dyer, S. E., Rhode Island

Univ., USA; Cooke, James D., Rhode Island Univ., USA; May 1998; 12p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Overcoat protection schemes for thin film devices have typically focused on inhibiting the growth of native oxides formed on the sensor surface, rather than on improving the passivating nature of these native oxides. Here, thin sputtered Cr overcoats and heat treatments in varying oxygen partial pressures enhanced the passivating nature of native Cr203 films formed on PdCr thin film strain gages. Results of strain tests using sensors protected using this approach are presented and the implications are discussed. PdCr gages with sputtered Cr overcoats withstood 12,000 dynamic strain cycles of 1100 micro-epsilon during 100 hours of testing at a temperature of 1000 C in air. Gage factors of 1.3 with drift rates as low as 0.1 Omega/hr were achieved for devices having a nominal resistance of approximately 100 Omega's. TCR's ranging from +550 ppm/C to +798 ppm/C were realized depending on the overcoat and thermal history. Possible mechanisms for an anomaly in the electrical characteristics of these films at 800 C and improvements in stability due to the use of overcoats are presented.
Author
Protective Coatings; Strain Gages; High Temperature; Palladium Compounds; Chromium Compounds; Thin Films; Oxides

19980206041 Rhode Island Univ., Dept. of Chemical Engineering, Kingston, RI United States
HIGH TEMPERATURE - THIN FILM STRAIN GAGES BASED ON ALLOYS OF INDIUM TIN OXIDE
Gregory, Otto J., Rhode Island Univ., USA; Cooke, James D., Rhode Island Univ., USA; Bienkiewicz, Joseph M., Rhode Island Univ., USA; May 1998; 12p; In English; See also 19980206002
Contract(s)/Grant(s): NAG3-1428; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A stable, high temperature strain gage based on reactively sputtered indium tin oxide (ITO) was demonstrated at temperatures up to 1050 C. These strain sensors exhibited relatively large, negative gage factors at room temperature and their piezoresistive response was both linear and reproducible when strained up to 700 micro-in/in. When cycled between compression and tension, these sensors also showed very little hysteresis, indicating excellent mechanical stability. Thin film strain gages based on selected ITO alloys withstood more than 50,000 strain cycles of +/- 500 micro-in/in during 180 hours of testing in air at 1000 C, with minimal drift at temperature. Drift rates as low as 0.0009%/hr at 1000 C were observed for ITO films that were annealed in nitrogen at 700 C prior to strain testing. These results compare favorably with state of the art 10 micro-m thick PdCr films deposited by NASA, where drift rates of 0.047%/hr at 1050 C were observed. Nitrogen annealing not only produced the lowest drift rates to date, but also produce the largest dynamic gage factors (G = 23.5). These wide bandgap, semiconductor strain sensors also exhibited moderately low temperature coefficients of resistance (TCR) at temperatures up to 1100 C, when tested in a nitrogen ambient. A TCR of +230 ppm/C over the temperature range 200 C <T <500 C and a TCR of -469 ppm/C over the temperature range 600 C <T <1100 C was observed for the films tested in nitrogen. However, the resistivity behavior changed considerably when the same films were tested in oxygen ambients. A TCR of -1560 ppm/C was obtained over the temperature range of 200 C <T <1100 C. When similar films were protected with an overcoat or when ITO films were prepared with higher oxygen contents in the plasma, two distinct TCR's were observed. At T <800 C, a linear TCR of -210 ppm/C was observed and at T > 800 C, a linear TCR of -2170 DDm/C was observed. The combination of a moderately low TCR and a relatively large gage factor make these semiconducting oxide films promising candidates for the active strain elements in high temperature thin film strain gages, particularly in applications where static strain measurement is desired.
Author
High Temperature Environments; Semiconducting Films; Indium Compounds; Tin Oxides; Strain Measurement; Strain Gages; Oxide Films; High Temperature Tests; Temperature Dependence

19980206047 Innovative Scientific Solutions, Inc., Dayton, OH United States
APPLICATION OF TWO-COLOR DIGITAL PIV FOR TURBOMACHINERY FLOWS
Gogineni, S., Innovative Scientific Solutions, Inc., USA; Estevadeordal, J., Innovative Scientific Solutions, Inc., USA; Sarka, B., Innovative Scientific Solutions, Inc., USA; Goss, L., Innovative Scientific Solutions, Inc., USA; Copenhaver, W., Wright Lab., USA; May 1998; 12p; In English; See also 19980206002
Contract(s)/Grant(s): F33615-97-C-2710; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The potential application of a Two-Color Digital-Particle-Image-Velocimetry (DPIV) system to turbomachinery-type flows was evaluated. This system records double-exposed color images onto a single CCD sensor (3060 x 2036 pixel) and eliminates the photographic-film processing time and subsequent digitization time as well as the complexities associated with conventional image-shifting techniques. The system was calibrated using simulated known displacements and gradients and was applied to the flowfield in a 20-in.-dia. axial fan. DPIV implementation issues such as optical access, seeding strategies, and blade-passage synchronization related to turbomachinery flows were explored. Instantaneous velocity measurements were made at different spanwise locations. These measurements provided instantaneous information on the blade wake region, the flow separation off the blades, and the interaction between successive blades and also allowed a greater understanding of the impact of these phenomena on turbomachinery performance.
Author
Particle Image Velocimetry; Velocity Measurement; Unsteady Flow; Wakes; Flow Characteristics; Turbocompressors

19980206049 NASA Lewis Research Center, Cleveland, OH United States
DEMONSTRATION OF PIV IN A TRANSONIC COMPRESSOR
Wernet, Mark P., NASA Lewis Research Center, USA; May 1998; 14p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Particle Imaging Velocimetry (PIV) is a powerful measurement technique which can be used as an alternative or complementary approach to Laser Doppler Velocimetry (LDV) in a wide range of research applications. PIV data are measured simultaneously at multiple points in space, which enables the investigation of the non-stationary spatial structures typically encountered in turbomachinery. Many of the same issues encountered in the application of LDV techniques to rotating machinery apply in the application of PIV. Preliminary results from the successful application of the standard 2-D PIV technique to a transonic axial compressor are presented. The lessons learned from the application of the 2-D PIV technique will serve as the basis for applying 3-component PIV techniques to turbomachinery.
Author
Particle Image Velocimetry; Transonic Compressors; Flow Velocity; Velocity Measurement; Wakes; Imagery

36
LASERS AND MASERS

19950025753 Aerospatiale, Direction des Estudes., Toulouse, France
STRIPPING BY LASER
Malavallon, Olivier, Aerospatiale, France; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 4 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

Laser beam stripping can be achieved using several active materials: YAG, CO2 Tea, or Excimer. The YAG laser appears to be the most efficient laser assessed in this report. However, the results obtained for productivity, quality, and type of stripping were very poor. Also, for stripping and on account of its specifications, the laser beam can only be used in an automated manner. In spite of these results, it seems that certain companies in Europe have recently developed technical solutions allowing better results to be obtained.
Derived from text
Laser Applications; Laser Beams; Paints; Removal; YAG Lasers

19960003855 California Univ., Davis, CA, United States
PHOTOINJECTOR-DRIVEN CHIRPED-PULSED FREE ELECTRON MASER
Lesage, G. P., California Univ., USA; Hartemann, F. V., California Univ., USA; Feng, H. X. C., California Univ., USA; Fochs, S. N., Cali-

fornia Univ., USA; Heritage, J. P., California Univ., USA; Luhmann, N. C., Jr., California Univ., USA; Perry, M. D., Lawrence Livermore National Lab., USA; Westenskow, G. A., Lawrence Livermore National Lab., USA; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 3 p; In English
Contract(s)/Grant(s): F30602-94-2-0001; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche; Original contains color illustrations

An ultra-short pulse, millimeter-wave free electron maser experiment is currently underway at UC Davis and Lawrence Livermore National Laboratory. A 8.5 kG, 30 mm period helical wiggler is used to transversally accelerate a train of one hundred 5 MeV, 0.25 nC, 1 ps duration micro bunches synchronously energized by a 20 MW, X-band photocathode RF linac. The photocathode is irradiated by a burst-mode, UV laser system which produces up to 100 pulses at 207 nm, with an energy of 10 mJ/pulse, and a pulse duration of 200 fs, at a repetition rate of 2.142 GHz. This system includes a 400 fs jitter synchronously modelocked AlGaAs semiconductor laser oscillator which is amplified by an eight-pass Ti:Al2O3 chirped pulse laser amplifier. The output of this amplifier is subsequently frequency quadrupled into the UV. Because the electron micro bunches are shorter than the radiation wavelength, the system coherently synchrotron radiates and behaves essentially as a prebunched FEM. In addition, by operating in a waveguide structure at grazing, where the bunch axial velocity in the wiggler matches the group velocity of the electromagnetic waves, one obtains output radiation pulses which are extremely short, and have greatly enhanced peak power. The device operates in the TE(sub 12) mode of a cylindrical waveguide, and will produce up to 2 MW of coherent synchrotron radiation power at 140 GHz, in a 15 ps FWHM pulse. The -3 dB instantaneous interaction bandwidth extends from 125 GHz to 225 GHz. The output pulse is chirped over the full interaction bandwidth. One of the major potential applications of such a device is an ultra-wideband millimeter-wave radar.
Author
Aluminum Gallium Arsenide Lasers; Light Amplifiers; Linear Accelerators; Masers; Millimeter Waves; Oscillators; Photocathodes; Pulsed Lasers; Synchrotrons; Ultraviolet Lasers; Wiggler Magnets

19960007229 Pennsylvania State Univ., Applied Research Lab., State College, PA, United States
LIDAR MEASUREMENTS OF REFRACTIVE PROPAGATION EFFECTS
Philbrick, C. R., Pennsylvania State Univ., USA; Blood, D. W., Pennsylvania State Univ., USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 13 p; In English; See also 19960007226; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

A multi-wavelength Raman lidar has been developed and used to measure the profiles of atmospheric properties in the troposphere under a wide range of geophysical conditions. The instrument measures the two physical properties which contribute to the refractive index at radio frequencies, water vapor concentration profiles from vibrational Raman measurements and neutral density determined from rotational Raman temperature profiles and surface pressure. The LAMP lidar instrument is transportable and has been used to make measurements at several locations in addition to our local Penn State University site, including shipboard measurements between Arctic and Antarctic and in the coastal environment at Point Mugu, CA. Lidar measurements of the atmospheric refractive environment, which are of particular interest, were made during 1993 at Point Mugu, CA, including the period of Project VOCAR (Variability of Coastal Atmospheric Refractivity). Both the lidar and balloon tropospheric measurements have been used for analyses of the propagation conditions by employing th Navy's RPO, IREPS and EREPS PC programs and comparisons have been made with the measured propagation conditions. On the short term (hour-to-hour throughout the day), the lidar derived profiles permit the examination of refractive layer stratification for guided-wave mode propagation.
Author
Atmospheric Effects; Atmospheric Moisture; Atmospheric Refraction; Optical Radar; Radar Measurement; Raman Spectra; Refractivity; Troposphere

19980206024 National Research Council of Canada, Ottawa, Ontario Canada
DEVELOPMENT AND APPLICATION OF LASER INDUCED INCANDESCENCE (LII) AS A DIAGNOSTIC FOR SOOT PARTICULATE MEASUREMENTS
Snelling, D. R., National Research Council of Canada, Canada; Smallwood, G. J., National Research Council of Canada, Canada; Campbell, I. G., National Research Council of Canada, Canada; Medlock, J. E., National Research Council of Canada, Canada; Guelder, O. L., National Research Council of Canada, Canada; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

LII is a promising diagnostic for in-situ measurements of particulates. The LII signal is shown to be proportional to soot volume fraction. Due to the large dynamic range of the LII technique, we have been able to measure time averaged soot concentrations in the part per billion range with a spatial resolution of approx. 0.5 mm in each dimension. The decay of the LII signal in the post evaporative region is shown to be a sensitive measure of primary particle size. A numerical model has been developed which accurately predicts post evaporative LII signal decay rates. The prediction of the excitation curve is unsatisfactory, with more work needed to correctly model the particle behaviour during the soot evaporation phase. Also, the model predicts that the prompt LII signal will vary as the 3.33 power of particle diameter. However, this predicted departure from strict proportionality between LII signal and soot volume fraction was not experimentally observed. Author
Soot; Concentration (Composition); Incandescence; Laser Applications; Measuring Instruments; Diffusion Flames; Particulates

19980206025 Institut de Mecanique des Fluides de Lille, France
USE OF IODINE FLUORESCENCE INDUCED BY LASER FOR MEASUREMENTS OF PRESSURE, TEMPERATURE, AND SPEED
APPLICATION DE LA FLUORESCENCE DE L'IODE INDUITE PAR LASER AUX MESURES DE PRESSION, TEMPERATURE ET VITESSE
Lefebvre, X., Institut de Mecanique des Fluides de Lille, France; Leporcq, B., Institut de Mecanique des Fluides de Lille, France; May 1998; 24p; In French; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Laser-induced iodine fluorescence, referred to as LIIF, is a non-intrusive optical method which allows one not only to visualize a flow, but to obtain local and instantaneous magnitudes such as pressure, temperature, and speed. Following confirmation in a static tube in which the parameters P and T are easily measurable, some measurements of the three parameters were taken on a supersonic jet by using a gaussian multimode laser and a tunable single mode dye laser.
Author
Laser Induced Fluorescence; Nonintrusive Measurement; Iodine Lasers; Temperature Measurement; Pressure Measurement; Velocity Measurement

19980206026 Cranfield Univ., School of Mechanical Engineering, Bedford, United Kingdom
DEVELOPMENT OF PLANAR LASER INDUCED FLUORESCENCE FOR FUEL: APPLICATION TO GAS TURBINE COMBUSTION
Greenhalgh, D. A., Cranfield Univ., UK; Bryce, D. J., Cranfield Univ., UK; Lockett, R. D., Cranfield Univ., UK; Harding, S. C., Cranfield Univ., UK; May 1998; 18p; In English; See also 19980206002; Original contains color illustrations
Contract(s)/Grant(s): CEC-AER2-CT92-0036; EPSRC-GR/H/78238; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Planar Laser Induced Fluorescence (PLIF) offers advantages over mechanical patternators, gas sampling, and other laser diagnostics in providing high resolution instantaneous two-dimensional images of liquid and vapour fuel concentration in operating gas turbine combustors. The technique has been developed at Cranfield and successfully applied to three different situations. Firstly the power of the method for fundamental mixing studies is illustrated with respect to a simple jet mixing experiment. Secondly the practical application of the method to an atmospheric pressure LPP combustor and a high pressure double annular combustor are presented. Radial and axial

imaging of both the liquid and vapour phases has been performed with fuel markers that are capable of distinguishing between different boiling-point fractions. Such data allows investigation of the fuel-air mixing in the combustor, as well as the behaviour of the spray cone angle and patternation with varying fuel rate.
Author
Laser Induced Fluorescence; Imaging Techniques; Combustion; Liquid Phases; Vapor Phases; Fuel Flow; Combustion Chambers

19980206027 Allison Engine Co., Rolls-Royce Aerospace Group, Indianapolis, IN United States
HIGH-TEMPERATURE SURFACE MEASUREMENTS OF TURBINE ENGINE COMPONENTS USING THERMOGRAPHIC PHOSPHORS
Alaruri, Sami, Allison Engine Co., USA; Brewington, Andy, Allison Engine Co., USA; May 1998; 6p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A laser-based system for single point high-temperature measurements of turbine engine component surfaces coated with thermographic phosphors is described. Decay lifetime calibration measurements obtained for Y203:Eu over the temperature range approx. 530-1000 C are presented. Further, the results obtained from a coupon placed in the outlet gas flow of an atmospheric combustor are described.
Author
Engine Parts; Temperature Measurement; Thermography; Phosphors; Surface Temperature; Coatings; Laser Induced Fluorescence

19980210689 Air Force Research Lab., Wright-Patterson AFB, OH United States
DEVELOPMENT OF A WIDEBAND AIRBORNE LASER DATA LINK
Gill, Robert A., Air Force Research Lab., USA; Feldmann, Robert J., Air Force Research Lab., USA; Apr. 1998; 7p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The USA Air Force Research Laboratory is conducting a program to develop a wideband airborne laser data link. The program successfully ground demonstrated a 1.1 gigabit/second (sec) full duplex data link over a distance of 150 kilometers (km). This ground demonstration was accomplished in Hawaii in September 1995. The system used in the ground demonstration has been redesigned and will be installed in two jet aircraft for flight demonstration at distances up to 500 km. These demonstration flights will begin in September 1998.
Author
Airborne Lasers; Data Links; Duplexers; Flight Tests; Laser Ranger/Tracker

19990014375 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
LASER POWER BEAMING: AN EMERGING NEW TECHNOLOGY FOR POWER AND PROPULSION IN SPACE
Bennett, H. E., Advisory Group for Aerospace Research and Development, France; Schadow, K. C., Editor, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 99-103; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

The potential of laser power beaming from a ground-based laser to satellites is discussed. The laser power may be used for propulsion and to increase the electric power available from the satellite. The increase relative to solar power generation can be an order of magnitude using the same size solar panels. For propulsion, it is proposed to beam the laser power through the atmosphere to a "tug satellite" which carries launched satellites to a higher orbit. The increased satellite electric power may be used to provide surge power to inhibit jamming of satellites in wartime, to overcome the increased atmospheric absorption in microwave operations, to provide orbit changes or corrections, to extend station keeping and satellite lifetime, and to transport malfunctioning satellites to the Space Station for repair and reinsertion in orbit. Key elements in the proposed concept include a 100 to 200 kW free-electron laser, a 3 km long underground ultra-high vacuum tube and a novel adaptive optical telescope. All elements in the concept have either been demonstrated or prototyped.
Author
Laser Power Beaming; Satellite Power Transmission; Spacecraft Power Supplies; Spacecraft Propulsion

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MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

19960024831 Fiat Aviazione S.p.A., Turin, Italy
DYNAMIC RESPONSE OF A CRYOGENIC LOX PUMP TO PRESSURE AND MASSFLOW FLUCTUATION
Munari, A., Fiat Aviazione S.p.A., Italy; Motta, M., Fiat Aviazione S.p.A., Italy; Loss Mechanisms and Unsteady Flows in Turbomachines; Jan. 1996; 8p; In English; See also 19960024804; Copyright Waived; Avail: CASI; A02, Hardcopy; A06, Microfiche

During the first stage flight many liquid propellant rockets have experienced longitudinal vibrations caused by interaction between the first launcher longitudinal mode and the dynamic of the propulsion system. This type of instability, called POGO, is closely related to the feeding pumps dynamic characteristics, especially when working at the lowest suction pressure. The knowledge of the pump dynamic response to pressure and mass flow oscillations is essential for the prediction and analysis of the POGO phenomena. The necessary information can be represented in form of a pump-transfer-matrix, which relates the fluctuating pressure and mass flow at pump inlet to the same quantities at pump discharge. This work summarizes the results of the experimental activities performed to extract the dwnamic transfer matrix of a liquid oxygen pump in both cavitating and non cavitating conditions.
Author
Mass Flow; Liquid Rocket Propellants; Cavitation Flow; Pressure Oscillations; Vibration Effects; Turbine Pumps; Combustion Chambers

19970006808 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
TRIBOLOGY FOR AEROSPACE SYSTEMS *LA TRIBOLOGIE POUR LES SYSTEMES AEROSPATIAUX*
Tribology for Aerospace Systems; Oct. 1996; 128p; In English; In French; 82d, 6-7 May 1996, Sesimbra, Portugal; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19970006809 through 19970006825
Report No.(s): AGARD-CP-589; ISBN 92-836-0029-0; Copyright Waived; Avail: CASI; A07, Hardcopy; A02, Microfiche

Fretting and wear of hinges, tracks, bearings, and gearboxes in airframes and engines is a constant problem for aircraft or other defense systems, as they induce failures and jamming, necessitating costly in-service inspections and replacement of parts. At the 82nd Meeting of the AGARD Structures and Materials Panel a Specialist's Meeting was held on Tribology for Aerospace Systems. The meeting was split into three sessions (18 papers): (1) new technologies such as coatings, new materials, lubrication and their behavior; (2) practical applications in airframes and their mechanical systems; and (3) practical applications to engines, both jet engines and reciprocal engines. The meeting was ended by a round table discussion.
Author
Aerospace Systems; Tribology; Lubrication; Airframes; Jet Engines; Wear Resistance; Engine Parts; Wear Inhibitors; Conferences

19970006813 SKF Engineering and Research Centre, Nieuwegein, Netherlands
THIN FILM LUBRICATION OF NON-SMOOTH SURFACES
Jacobson, Bo, SKF Engineering and Research Centre, Netherlands; Tribology for Aerospace Systems; Oct. 1996; 8p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The reliable performance of heavily-loaded mechanical contacts can only be sustained over long periods when a lubricant film fully separates the two bodies and asperities do not interact. Engineering surfaces do have a certain degree of roughness and this would then determine the required thickness of the lubricant film. Unfortunately, thick lubricant films have disadvantages such as high power losses (oil churning) or they may not be attainable because of prescribed lubricants or high operating temperatures. In order to optimize the quality of the surface against these conflicting requirements, or in order to design specific surfaces for extreme operating conditions, a thorough understanding of the mechanisms of micro EHL or asperity lubrication

is needed. This required level of understanding goes beyond the current one which employs Lambda, the ratio between calculated film thickness and combined surface roughness. When detailed analysis of the behavior of surface asperities in heavily-loaded elastohydrodynamic contacts includes non-Newtonian effects, two phenomena become evident. One phenomenon is the possibility to describe theoretically the collapse of an oil film and to determine when a lubricated rough surface in contact with another surface can come into solid contact through the lubricant film. The other phenomenon, which is closely related to the first one, is the explanation of the well-known fact that the oil film thickness needed to separate two elastohydrodynamically lubricated surfaces is strongly dependent on the structure of the surface roughness and not only on the values of the different surface roughness parameters. Both of these phenomena can only be explained if the pressure distribution in the lubricant film has such high frequency variation that local asperities in the lubricant film become elastically deformed by the pressure distribution, making the contact surfaces conform much more than in the unstressed state outside the high pressure contact zone.
Author
Thin Films; Lubrication; Surface Roughness; Film Thickness; Lubricants

19970006814 Federal Inst. for Materials Research and Testing, Berlin, Germany
MACHINING AND SLIP-ROLLING OF CERAMICS
Woydt, M., Federal Inst. for Materials Research and Testing, Germany; Effner, U., Federal Inst. for Materials Research and Testing, Germany; Tribology for Aerospace Systems; Oct. 1996; 6p; In English; See also 19970006808
Contract(s)/Grant(s): Wo-521-1-1; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Slip-rolling testing of ceramic samples for friction and wear was done in a twin disc tribometer of the Amsler-type at 3 GPa. Lubricant water and paraffin oil without any additives was used. The surface of the ceramics were machined with different processes, resulting in different surface roughnesses (i.e. rough and fine honed, rough and fine grounded, rough and fine lapped and rough and fine polished). Ceramic materials like HIP-Si3N4 (NBD 200), SiC (EKasic D) and Si3N4-TiN (EDM) were investigated. HIP-Si3N4 and Si3N4-TiN in paraffin oil generally show a small wear coefficient in the range of 10(exp -9) cu mm/Nm. In paraffinic oil, the wear coefficient of Si3N4 and Si3N4-TiN correlates to the initial surface roughness and the material removal rate. The wear coefficient in water is for both materials higher by two orders of magnitude. The surface of the SiC components shows pitting after the tribological tests, independent from the ambient media.
Author (revised)
Ceramics; Surface Roughness; Machining; Surface Finishing; Silicon Nitrides; Wear; Ball Bearings; Rolling Contact Loads

19970006816 Centre National d'Etudes Spatiales, Toulouse, France
TRIBOLOGICAL PROBLEMS IN SPACECRAFTS
Borrien, A., Centre National d'Etudes Spatiales, France; Tribology for Aerospace Systems; Oct. 1996; 10p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Spacecraft are very specific vehicles which have to work over a long period of time after experiencing severe mechanical stresses, without any maintenance and in a harsh environment, quite difficult to reproduce on ground. Economic constraints leading to the mass minimization and the low power availability complete the quick description of a situation propitious to mechanisms failures. The tribological problems are then the crucial point to assess in order to control in orbit mechanisms behavior, and this will require a good knowledge of kinematics, materials, relative velocities and contact pressure. Increasing complexity of payloads (especially in the field of optical instruments), microvibration requirements needed for satellite attitude stability, fifteen-year service life, deployment and pointing of very large appendages (as for radar missions) point out the wide range of satellite mechanism requirements. The aim of this paper is to present the features of the space environment, the tribological solutions achieved by current programs, and the limits of these technologies. The surface adhesion due to ultra-vacuum, materials outgassing, the problem of thermal regulation, and the difficulties of controlling fluid lubricants migration under microgravity are discussed. We show that the necessity of ground tests and the constraints brought by the launch vibrations could highly influence the chosen solution. The main onboard functions calling for a mechanism are briefly described and are taken as actual examples for the description of the family of dry and wet space lubricants. Some general recommendations for space tribology are given in the last part, and the research and technology program performed in Europe under CNES and ESA funding is briefly discussed.
Author (revised)
Tribology; Spacecraft Lubrication; Lubricants

19970006818 Defence Research Agency, Structural Materials Centre, Farnborough, United Kingdom
IMPROVING SOLID LUBRICATED AEROSPACE BEARINGS
Mortimer, B., Defence Research Agency, UK; Mason, S., Defence Research Agency, UK; Tribology for Aerospace Systems; Oct. 1996; 10p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Plastics-based liners, 0.3-0.4 mm thick, containing polytetrafluoroethylene are usually mated against steel counterfaces in dry bearings used extensively in aircraft and helicopters. Wear experiments have been made on a number of these liners, using a tri-pin on disc apparatus, to examine the effect of decreasing the roughness of the steel and other counterfaces manufactured from harder materials and coatings. For some hard materials, WC-Co and alumina, the primary importance of hardness and surface roughness on liner wear is confirmed; the smoother the surface the lower the wear. Other materials, and in particular physical vapor deposited titanium nitride, do not lead to lower liner wear rates. The very low liner wear obtained against cermet and alumina counterfaces suggest that bearing lives could be extended considerably, perhaps by an order of magnitude, by using harder counterfaces than the hardened AISI 440C stainless steel which is currently used.
Author
Bearings; Solid Lubricants; Polytetrafluoroethylene; Linings; Wear

19970006820 Porto Univ., Faculdade de Engenharia, Portugal
EHD ANALYSIS OF A ROLLER/INNER RING CONTACT IN A JET ENGINE ROLLER BEARING
Seabra, J., Porto Univ., Portugal; Campos, A., Porto Univ., Portugal; Tribology for Aerospace Systems; Oct. 1996; 12p; In English; See also 19970006808
Contract(s)/Grant(s): Aero-0007-A(c); Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper deals with the analysis of an EHD (elastohydrodynamic) roller/inner ring contact in a roller bearing for a jet engine application. The equations for the EHD lubrication problem, with longitudinal roughness, and their numerical solution for a Newtonian fluid are presented. A typical geometry of a jet engine roller bearing is studied in detail, both in terms of lubricant film thickness and of elastic deformation of the roller. The results obtained show that the geometry of the roller in the transverse direction, produces a contact area of particular shape, avoiding the appearance of significant edge overpressures, independently of the operating conditions. The influence of the load and rolling speed on the film thickness, both for smooth and wavy surfaces, was also investigated. The results obtained support the conclusion that the surface waviness considered produce a small decrease of the film thickness, when compared with the smooth case, and that the elastic deformation of the waviness is strongly dependent on the rolling speed. Finally a correlation of the EHD film thickness results for the the roller/inner ring contact is obtained and compared with known solutions.
Author
Elastohydrodynamics; Roller Bearings; Jet Engines; Engine Parts; Lubrication; Mathematical Models

19970006821 Wright Lab., Aero Propulsion and Power Directorate, Wright-Patterson AFB, OH United States
ROLLING CONTACT TESTING OF VAPOR PHASE LUBRICANTS
Forster, Nelson H., Wright Lab., USA; Tribology for Aerospace Systems; Oct. 1996; 8p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Material screening tests have been performed with four candidate vapor phase lubricants under rolling contact conditions. The lubricants evaluated were; t-butyl phenyl phosphate (TBPP), polyalphaolefin (PAO), cyclophosphazine (X-1P), and PAO blended with 15

percent TBPP (PAO+). A factorial analysis was used to separate the effects of lubricant; bearing steel, T15 vs. thin dense chrome coated T15; cage material, AISI 4340 vs. Monel 400; and ball material, T15 vs. NBD 200 Si3N4. Response variables included in the analyses were the bearing friction coefficient, wear rate, and life under accelerated conditions. The type of lubricant was significant at the 90 percent confidence level for all three response variables, with the PAO+ and TBPP showing the best results. In general, bearing materials containing Fe showed improved performance over materials which do not contain Fe at the bearing surface.
Author
Gas Lubricants; Bearings; Lubrication; Rolling Contact Loads; Wear Tests; Wear; Vapor Phase Lubrication

19970006822 Turbomeca S.A. - Brevets Szydlowski, Bordes, France
THE RELIABILITY OF THE BEARINGS OF SMALL AND MEDIUM TURBINES BEING MORE AND MORE DEPENDENT ON TRIBOLOGY *LA FIABILITE DES ROULEMENTS DES PETITES ET MOYENNES TURBINES DE PLUS EN PLUS DE'PENDANTE DE LA TRIBOLOGIE*
Paty, Gerard, Turbomeca S.A. - Brevets Szydlowski, France; Cheftel, Brigitte, Turbomeca S.A. - Brevets Szydlowski, France; Tribology for Aerospace Systems; Oct. 1996; 10p; In French; See also 19970006808; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Bearings reliability in the mechanical industry was in the past very dependent on material fatigue. Because of their high speed, aeronautical applications added high friction conditions and then generated more surface damages. The important progress made with steel quality, particularly with vacuum elaborated types used in aeronautics now prevent most of the classical deep initiated fatigue failures. Defect initiation moved toward the contact surface which therefore becomes the research and development center of interest of the future. The high speed bearings are lubricated in the most effective manner. The creation of an oil film which separates the surfaces is essential to avoid metal to metal contact. New computer codes such as BEDALES and QUASAR, developed with the support of the European Community during the last years, led to a better understanding and prediction of this behavior. Nevertheless turbine engines continue to suffer defects whose initiations are often linked with tribological weaknesses. Skidding is one of the most important. It depends widely on material surface temperature capacity. Pollution of oil systems with hard particles is another source currently being investigated in terms of damage tolerance. Bearing cages also have to withstand severe contact conditions which overlap the capacity of the current technology. Surface and subsurface stresses have an essential role in the control of the fatigue failure initiation and development. The investigations on a set of used bearings with new NDT techniques as Barkhausen noise show promising information for developing new tools in this area.
Author (revised)
Bearings; Gas Turbine Engines; Tribology; Wear; Lubrication; Engine Parts

19970006823 Motoren- und Turbinen-Union G.m.b.H., Munich, Germany
AIRSEALS FOR ADVANCED MILITARY JET ENGINES
Uihlein, T. J., Motoren- und Turbinen-Union G.m.b.H., Germany; Tribology for Aerospace Systems; Oct. 1996; 20p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

In advanced military jet engines airseals represent one of the most challenging key technologies. Without properly functioning seal systems it is not possible to attain the high pressure ratios needed for high efficiencies and low specific fuel consumption. Moreover a poorly functioning seal system can result in blade losses and titanium fire, or in heavy damage to the rotor in the case of labyrinth seals, which is even more dangerous. to overcome these problems a basic understanding of the wear mechanisms of the different seal systems is necessary. This requires rub testing under simulated engine conditions to determine the limitations of each system. Only with this knowledge can the design and improvement of abradables, fin coatings or tip coatings be successful. Apart from abradability this optimization also includes, for example, erosion resistance, high cycle fatigue strength of tip coated blades, or damage tolerance of abradables against blade passing frequencies.
Author (revised)
Seals (Stoppers); Jet Engines; Wear; Engine Parts

19970006824 Army Tank-Automotive Research and Development Command, Warren, MI United States
HIGH TEMPERATURE TRIBOLOGY FOR FUTURE DIESEL ENGINES
Bryzik, Walter, Army Tank-Automotive Research and Development Command, USA; Kamo, Roy, Adiabatics, Inc., USA; Tribology for Aerospace Systems; Oct. 1996; 8p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Diesel engines will be operated at higher cycle temperatures in the future. The higher cycle creates problems of the top ring, piston, valve seats, valve guides, and cylinder liner. Current lubricating oil with thermal oxidative stability of 204 C is inadequate. Polyol ester base formulated synthetic oil such as Stauffer Chemical SDL-1 or US TACOM MRI-1 with 310 C thermal oxidative stability could possibly be the next generation lubricating oil. However, as diesel engines designed to include advanced structural ceramics or composites for 'adiabatic' operation become feasible, the thermal stability of the lubricating oil will approach 445 C. to withstand the top ring reversal temperature beyond 310 C, polyphenol ester base oil and other high temperature liquid lubricants will be sought. The highly aromatic polyphenol ether type oil has thus far shown very little promise. The hybrid piston with solid lubricated top compression rings and a hydrodynamically lubricated oil ring has shown encouraging results. It can be designed to offer as much as 150 C higher top ring reversal temperature capability. If higher hydrodynamically lubricated oil becomes available, the top ring reversal temperature can also be elevated by a temperature difference of approximately 150 C. The hybrid piston conceptually drags a thin oil film into the upper dry solid lubricated cylinder liner regions by traversing through the hydrodynamic lubricated region during bottom dead center travel. This small amount of oil film is sufficient to form a hard thin film lubricant of very low coefficient of friction. Densified Cr2O3 coating on Cr2O3 coating has demonstrated the possibility to operate at 380 C top ring reversal temperature with acceptable wear and life. NASA PS212 with Stellite 6B was also tested without liquid lubricant.
Author (revised)
High Temperature Lubricants; Diesel Engines; Solid Lubricants; Lubricating Oils; Tribology; Lubrication

19970006825 Federal Inst. for Materials Research and Testing, Berlin, Germany
TRIBOLOGICAL ASSESSMENTS AND CONCEPTS FOR AN OILFREE INTERNAL COMBUSTION ENGINE
Woydt, M., Federal Inst. for Materials Research and Testing, Germany; Tribology for Aerospace Systems; Oct. 1996; 14p; In English; See also 19970006808; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Unlubricated engines can be realized from the tribological point of view, if wear coefficients of sliding couples lower than 5x10(exp -8) cu mm/(N m) can be demonstrated, which are independent from ambient temperature and sliding speed. A review of published tribological data and a database search provided no couples with such a low wear coefficient at 22 C and 400 C. Known unlubricated sliding couples with wear coefficients around 10(exp -7) cu mm/N m open the frame to build up such engines for basic studies.
Author (revised)
Internal Combustion Engines; Tribology; Lubrication; Wear Resistance; High Temperature Lubricants

19970021152 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France
PROPULSION AND ENERGY ISSUES FOR THE 21ST CENTURY *LES ENJEUX DE LA PROPULSION ET DE L'ENERGETIQUE A L'AUBE DU 21EME SIECLE*
Henderson, Robert E., Editor, Universal Technology Corp., USA; Kuentzmann, Paul, Office National d'Etudes et de Recherches Aerospatiales, France; Besser, Hans-Ludwig, Bayern-Chemie G.m.b.H., Germany; Stull, Frank D., Universal Technology Corp., USA; Waltrup, Paul, Johns Hopkins Univ., USA; Ronald, Terry, Wright Lab., USA;

Lazalier, Glendon, Sverdrup Technology, Inc., USA; Hill, Richard J., Wright Lab., USA; Cifone, Anthony J., Naval Air Warfare Center, USA; Meyer, Lee, Phillips Lab., USA; Edelman, Raymond, Boeing North American, Inc., USA; Pesce-Rodriguez, Rose, Army Research Lab., USA; Kolkert, Willem J., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Bennett, Harold E., Bennett Optical Research, Inc., USA; Schadow, Klaus C., Naval Air Warfare Center, USA; Mar. 1997; 68p; In English
Report No.(s): AGARD-R-824; ISBN 92-836-1054-7; Copyright Waived; Avail: CASI; A04, Hardcopy; A01, Microfiche

This report provides a review and capability projection for a number of propulsion technology topics that could ensure and significantly enhance NATO air dominance well into the next century. The main topic deals with a 'Hypersonic Air Breathing Missile' that discusses in an exemplary way the military uses and technology requirements for a new weapon with unprecedented capabilities. This hypersonic missile, traveling at speeds between Mach 6-8, could be used as a medium distance weapon against hardened ground targets, very high value aerial targets, or time critical targets such as mobile theater ballistic missile launchers. Launched from the ground or air, it would cover up to 1500 kilometers in about 15 minutes and be virtually indefensible due to its hypersonic speed. The critical technology is the scramjet engine operating on a liquid hydrocarbon fuel that permits immediate launch and full control of engine power throughout the flight path. Detailed application and technology requirements are described. Maintaining air dominance in the battlefield is predicated on controlling the air space with a variety of air vehicles and missile systems; these are generally powered by gas turbine engines and rocket motors. Gas turbines will continue to be the most cost effective propulsor that can provide the necessary power for maneuverability, armament control and mission flexibility. Rocket engines offer very high specific power that is a fundamental requirement for many types of missiles and boosters. A technology development survey is given that briefly describes the considerable improvements to be expected in performance and economics. Doubling the range and halving the reaction time for fighter and global strike aircraft, and increasing by 50% the reach of global transport aircraft are well within sight. Three examples are given that introduce or foster new types of propulsion. The pulse detonation wave engine offers a marked increase in efficiency and a simplification of design over current rocket and ramjet engines. Gun projectiles may be driven electrically or by liquid charges, both of which promise to overcome the limitations posed by high energy solid propellants. Laser power beaming offers a means of transferring energy to vehicles over large distances. Despite the immense technological complexity, it may open entirely new roads for powering aerial vehicles in the more distant future. First applications may be in repowering satellites for extended operations and shifting of orbits. These technology and application reviews were originally developed under the auspices of the AGARD Aerospace 2020 Study. They are based on input from the AGARD Propulsion and Energetics and other Panels, the Aerospace Applications Study Committee of AGARD, and many contributions from outside AGARD. This report is but one example of the value that AGARD has provided to the military community, often at very short notice, over the past 45 years of its history.
Derived from text
Propulsion; Air Breathing Engines; Ballistic Missiles; Hypersonic Speed; Time Dependence; Technology Utilization

19980206007 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Antriebstechnik, Cologne, Germany
INVESTIGATION OF THE SPRAY DYNAMICS OF AEROENGINE FUEL INJECTORS UNDER ATMOSPHERIC AND SIMULATED PRESSURE CONDITIONS
Behrendt, T., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Hassa, C., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; May 1998; 14p; In English; See also 19980206002
Contract(s)/Grant(s): BWB-E/L41A/V0077/P5131; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The two phase flow in the nearfield of an airblast atomizer in a cylindrical confinement was investigated with a three component (3D) dual mode Phase Doppler Anemometer (PDA). An algorithm for the calculation of the mass flux in a strongly swirling spray was derived. The algorithm makes use of all three velocity components. The improved performance relative to a 2D-algorithm is shown for an atmospheric spray. The error of the integrated mass flux is about +/- 15% at a distance of more than 10 mm behind the nozzle exit. The investigations were made in an attempt to get first information on the two phase flow under real pressure condition where the dense spray starts to modify the flow pattern and hence the fuel distribution. Similarity rules were derived for scaling the combustor idle condition with respect to the particle number concentration in the spray. The measurements were made under atmospheric and simulated pressure condition. The measured spray properties agreed well with the expected results calculated from the similarity rules. Several effects of the spray on the gas phase were identified under simulated pressure. A reduced turbulence of the gasphase, a decreased dispersion of the spray and a degradation of the effective swirl number were identified as dense spray effects. These phenomena are likely to occur under real pressure as well. Other effects identified were results of the particle inertia. For the correct interpretation of the results it was necessary to estimate the degree to which the particle behaviour is influenced by its inertia under simulated and real pressure. Together with this evaluation the simulation of real engine condition with respect to the particle number concentration was successful within certain limits.
Author
Fuel Injection; Two Phase Flow; Spraying; Atomizers; Anemometers; Flow Measurement; Velocity Measurement; Algorithms; Atmospheric Pressure; Pressure Ratio

19980206011 Defence Research Agency, Propulsion Dept., Farnborough, United Kingdom
DIAL MEASUREMENTS ON A GAS TURBINE EXHAUST
Brundish, K. D., Defence Research Agency, UK; Wilson, C. W., Defence Research Agency, UK; Moncrieff, J. T. M., Spectrasyne Ltd., UK; May 1998; 8p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper summarises work undertaken by Defence Evaluation and Research Agency (DERA) and SPECTRASYNE, and examines the technique of DIAL as a measurement of gas turbine engine emissions. The work was jointly funded by the UK MOD and UK DTI. The DIAL technique is based on LIDAR, which is a laser based range finding system, similar to RADAR. With the use of a tuneable laser it can be adapted for spectroscopic measurements of mass flux. This technique was used to measure NO(x) and unburnt hydrocarbon mass fluxes from the vertical engine detuner, for two engines at three running conditions. The NO(x) measurements were converted to vppm values at the engine exit plane to allow comparison with intrusive probe measurements. The DIAL measurements of NO(x) at idle and max. continuous were within 25% of the probe measurements. The DIAL measurements are performed at a plane downstream of the detuner exit, and rely on the wind to move the plume through this plane. Low wind speeds which are usually associated with variable wind directions, can result in increased uncertainty. However, minimum reheat values were considerably different, and cannot be explained by these uncertainties. This anomaly is as yet unresolved, although a possible solution may be from continued reactions in the detuner. The unburnt hydrocarbon (UHC) measurements from both DIAL and the probe exhibited the same trends, although a direct comparison was not possible due to the unknown composition of the hydrocarbons exiting the engine. This made it impossible to calculate concentration from the mass flux measurements. Further work on gas turbine engines should be performed under less arduous conditions for DIAL measurements than the reported tests. Measurements in open areas directly behind the engine with a horizontal plume, offers the best conditions.
Author
Exhaust Emission; Optical Radar; Measuring Instruments; Nitrogen Oxides; Exhaust Gases; Gas Turbine Engines; Mass Flow Rate

19980206012 Sverdrup Technology, Inc., Arnold Engineering Development Center Group, Arnold AFS, TN United States
UV ABSORPTION MEASUREMENTS OF NITRIC OXIDE COMPARED TO PROBE SAMPLING DATA FOR MEASUREMENTS IN A TURBINE ENGINE EXHAUST AT SIMULATED ALTITUDE CONDITIONS
Howard, R. P., Sverdrup Technology, Inc., USA; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Nitric oxide measurements were conducted in the exhaust of a turbofan engine at simulated altitude conditions in a ground-level test cell using both optical nonintrusive and conventional gas sampling

techniques. NO-UV absorption measurements, using both resonance and continuum lamps, were made through several chords of the exhaust flow near the nozzle exit plane as a part of a larger effort to characterize aircraft exhaust constituents over a wide range of steady-state engine operating conditions. This paper describes the NO-UV absorption measurements and compares radial profiles of NO concentrations and emission indices with measurements obtained using conventional gas sampling and tunable diode laser infrared absorption.
Author
Ultraviolet Absorption; Absorption Spectroscopy; Nitric Oxide; Turbofan Engines; Laser Spectroscopy; Exhaust Emission; Flow Measurement

19980206014 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Antriebstechnik, Cologne, Germany
APPLICATION OF 3D-LASER TWO FOCUS VELOCIMETRY IN TURBOMACHINE INVESTIGATIONS
Beversdorff, M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Matziol, L., Technische Univ., Germany; Blaha, C., Technische Hochschule, Germany; May 1998; 8p; In English; See also 19980206002
Contract(s)/Grant(s): BMBF-BEO/310326801D; BMBF-BEO/310326801X; BMBF-20T9402; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The further development of turbomachines is driven by the improved understanding of the three dimensional, secondary flow processes. Therefore experimental data are needed to analyse the 3D flow in this machines and to provide data for computer code validation. In this context a 3D-L2F velocimeter was developed which enables 3D flow vector measurements under the difficult conditions of turbomachines were the optical access is restricted. The new design of the 3D-L2F velocimeter includes also a special multi-colour set-up with selectable beam separation that helps to reduce measurement time especially in turbulent flow regions, where conventional L2F systems are working rather time consuming. A special seeding probe which can be placed very close to the turbomachine inlet without generating flow distortions provides an increase of the particle concentration in the seeded streamline that passes the L2F probe volume, thus contributing also to a further measuring time reduction. Flow investigations in a transonic compressor are described and selected results of the secondary flow field obtained are presented.
Author
Laser Doppler Velocimeters; Secondary Flow; Velocity Measurement; Flow Measurement; Turbulent Flow; Nonintrusive Measurement; Turbomachinery

19980206015 Deutsche Gesellschaft fuer Luft- und Raumfahrt, Inst. fuer Physikalische Chemie der Verbrennung, Stuttgart, Germany
CHARACTERIZATION OF GAS TURBINE COMBUSTION CHAMBERS WITH SINGLE PULSE CARS THERMOMETRY
Lueckerath, R., Deutsche Gesellschaft fuer Luft- und Raumfahrt, Germany; Bergmann, V., Deutsche Gesellschaft fuer Luft- und Raumfahrt, Germany; Stricker, W., Deutsche Gesellschaft fuer Luft- und Raumfahrt, Germany; May 1998; 8p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Temperature results of three measuring campaigns with the mobile CARS system of the DLR Stuttgart are presented. The experiments were performed on different combustion chambers: a thrust nozzle test facility, a RQL combustor, and a ramjet combustor. Single pulse CARS N2 thermometry was used to characterize the homogeneity of the flame at the exit plane of the combustion chamber, to address the quality of mixing of fuel-rich burnt gas of the primary zone with secondary air, to find an improved design for the H2 injection into a high speed air flow, and to measure the temperature and pressure variations in the shock controlled free jet flame. In the last case both the temperature and the pressure could be determined from the CARS spectrum.
Author
Combustion Chambers; Temperature Measurement; Gas Turbine Engines; Measuring Instruments; Nonintrusive Measurement; Combustion

19980206016 Rolls-Royce Ltd., Applied Science Lab., Derby, United Kingdom
CARS DIAGNOSTICS ON MODEL GAS TURBINE COMBUSTOR RIGS
Black, John D., Rolls-Royce Ltd., UK; Wiseall, Stephen S., Rolls-Royce Ltd., UK; May 1998; 12p; In English; See also 19980206002
Contract(s)/Grant(s): CEC-AERO-CT92-0036; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Rolls-Royce Applied Science Laboratory has been active in CARS (Coherent Anti-Stokes Raman Spectroscopy) thermometry in aero gas turbine related combustion rigs for over ten years. This paper describes the mobile CARS system currently used for temperature measurements on research rigs, the current limitations of the technique, and future plans for improvements and implementation.
Author
Temperature Measurement; Gas Turbine Engines; Raman Spectroscopy; Nonintrusive Measurement; Exhaust Gases; Combustion; Combustion Chambers

19980206032 Rolls-Royce Ltd., Civil Aero Engines, Derby, United Kingdom
TURBOMACHINERY BLADE TIP MEASUREMENT TECHNIQUES
Heath, S., Rolls-Royce Ltd., UK; Slater, T., Rolls-Royce Ltd., UK; Mansfield, L., Rolls-Royce Ltd., UK; Loftus, P., Rolls-Royce Ltd., UK; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The efficiency of axial flow compressors and turbines is critically dependent on the size of the tip to casing gaps (tip clearance) as is the surge margin of compressors. Optimisation of tip clearance control schemes requires measurements of tip clearances throughout the operating envelope of the engine. The dynamic design of rotor blading to avoid damaging integral order and self excited resonance's is complex and still defies routine right-first time design. This necessitates monitoring of blade vibration during testing which is time consuming and costly with conventional strain-gauging techniques. Both of the above requirements may be addressed by easily mounted tip probes, the design and operation of which are discussed in this paper. Until recently the market for such devices has provided insufficient incentive for instrumentation suppliers to invest in the development of such devices leaving engine manufacturers to develop their own solutions to these unique problems. The Rolls-Royce experience is described.
Author
Blade Tips; Clearances; Measuring Instruments; Structural Vibration; Vibration Measurement; Stress Measurement; Nonintrusive Measurement

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QUALITY ASSURANCE AND RELIABILITY

19950017085 Defence Research Agency, Structural Materials Centre., Farnborough, Hampshire, United Kingdom
NON-DESTRUCTIVE DETECTION OF CORROSION FOR LIFE MANAGEMENT
Bruce, David A., Defence Research Agency, UK; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 8 p; In English; See also 19950017076; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

In recent years, aircraft operators have been driven to increased use of Non-Destructive Evaluation (NDE) to ensure airworthiness during life extensions for ageing aircraft or as an integral part of a damage tolerant lifting philosophy. Major airframe static and fatigue tests are routinely used to highlight problem areas on airframes where design limitations or changes of usage may lead to early failures. The results of such tests become progressively less reliable as the age of the airframe increases and the operating conditions diverge from those under which the tests were conducted. Increased inspection, whether by visual or other means is usually the only alternative to wholesale refurbishment or replacement of aircraft or components. Almost all of the development to date of NDE techniques for corrosion detection and characterization has been concentrated on existing airframe materials, principally Aluminum alloys and steels. The current capabilities of corrosion detection techniques will be reviewed and current research aimed at areas where there is a requirement for

improved detection capability will be described. New materials, such as Polymer Matrix Composites, will experience different types of 'corrosive' deterioration. The capability of NDE methods to detect material degradation in new composite materials will be discussed. Finally, reliance on NDE, choice of NDE technique and optimal scheduling of inspections all require an assessment of the reliability of NDE methods. It will be shown that a range of NDE techniques with differing capabilities and characteristics will be required to ensure compatibility with maintenance schedules if full use is to be made of NDE for life management of structures which may be subject to corrosion.
Author
Aircraft Structures; Airframe Materials; Corrosion; Degradation; Deterioration; Inspection; Nondestructive Tests

19950017087 National Aerospace Lab., Amsterdam, Netherlands
EDDY CURRENT DETECTION OF PITTING CORROSION AROUND FASTENER HOLES
Heida, J. H., National Aerospace Lab., Netherlands; Thart, W. G. J., National Aerospace Lab., Netherlands; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 10 p; In English; See also 19950017076; Sponsored by Royal Netherlands Air Force; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

An evaluation of the eddy current technique for the detection and depth assessment of corrosion around fastener holes in F-16 lower wing skins is described. The corrosion type in this structure is pitting corrosion at the countersink edge of the fastener holes. Due to a corrosion clean-up limit of only 1.5 - 2.5 percent, a maximum thickness reduction in the range of 0.08 - 0.32 mm is allowed (depending on local skin thickness). This specifies the needed sensitivity for in-service corrosion inspection. In the evaluation use was made of specimens cut out of the F-16 lower wing skin structure. In total twelve specimens were exposed to an accelerated corrosion test (EXCO-test). Eddy current inspection of the specimens with installed fasteners was performed with a standard eddy scope and four different eddy current probes. After the eddy current inspection cross-sections of the twelve-specimens were made to determine the extent of pitting corrosion at the countersink edges. After evaluation of the inspection results the following conclusions can be drawn: for in-service detection of countersink edge corrosion standard visual inspection is the preferred technique regarding the simplicity, sensitivity and reliability of inspection; and for the purpose of depth assessment the eddy current technique is capable of detecting countersink edge corrosion with a depth from about 0.1 mm. Due to the corrosion clean-up limit of only 1.5 - 2.5 percent (0.08 - 0.32 mm), however, the eddy current technique is considered not applicable for in-service depth assessment of countersink edge corrosion in F-16 lower wing skins.
Author
Accelerated Life Tests; Corrosion; Corrosion Tests; Eddy Currents; Fasteners; Holes (Mechanics); Inspection; Pitting

19950017092 NASA Langley Research Center, Hampton, VA, United States
NEW NONDESTRUCTIVE TECHNIQUES FOR THE DETECTION AND QUANTIFICATION OF CORROSION IN AIRCRAFT STRUCTURES
Winfree, W. P., NASA Langley Research Center, USA; Cramer, K. E., NASA Langley Research Center, USA; Johnston, P. H., NASA Langley Research Center, USA; Namkung, M., NASA Langley Research Center, USA; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 6 p; In English; See also 19950017076; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

An overview is presented of several techniques under development at NASA Langley Research Center for detection and quantification of corrosion in aircraft structures. The techniques have been developed as part of the NASA Airframe Structural Integrity Program. The techniques focus on the detection of subsurface corrosion in thin laminated structures. Results are presented on specimens with both manufactured defects, for calibration of the techniques, and on specimens removed from aircraft.
Author
Aircraft Structures; Airframe Materials; Corrosion; Corrosion Tests; Defects; Detection; Laminates; Nondestructive Tests

19950017094 KOMPOZIT Corp., Kaliningrad, Russia
PROBLEMS OF PREDICTING MATERIAL PROPERTY RETENTION DURING LONG TERM SERVICE
Gordeev, Yu. P., KOMPOZIT Corp., Russia; Khomutov, A. M., KOMPOZIT Corp., Russia; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 6 p; In English; See also 19950017076; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A procedure of materials-science studies accompanying the process of product development, manufacture and service is offered. It provides correct selection of materials, trustworthy prediction of their behavior, high reliability of their operation in products of space-rocket application. Reliable prediction of material behavior during long-term service is achieved by breaking up the complex effect of the environment into individual factors and by analyzing the effect of each factor on the properties of the material.
Author
Aging (Materials); Durability; Environmental Tests; Product Development

19950017182 Advisory Group for Aeronautical Research and Development, Structures and Materials Panel, Oxford, United Kingdom
POD ASSESSMENT OF NDI PROCEDURES USING A ROUND ROBIN TEST *LES TESTS COMPARATIFS INTER-LABORATOIRES POUR L'EVALUATION DE LA PROBABILITE DE DETECTION (POD) DES PROCEDURES NDI*
Jan 1, 1995; 40p; In English
Report No.(s): AGARD-R-809; AD-A292019; ISBN 92-836-1010-5; Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Under the auspices of the AGARD Structures and Materials Panel R&D Cooperation Program, a round-robin NDI demonstration has been carried out. Six laboratories in four NATO countries participated in the project. The aim of the project was to determine the sensitivity and reliability of NDI procedures presently employed by the participating laboratories and to establish whether or not the procedures would be adequate for the implementation of a damage-tolerance based maintenance approach or whether improved methods are required.
Author
Aircraft Maintenance; Damage; Damage Assessment; Holes (Mechanics); Inspection; Nondestructive Tests; Statistical Analysis; X Ray Inspection

19960020743 Princeton Univ., Dept. of Civil Engineering and Operations Research., NJ United States
STATISTICAL PROPERTY OF WIDESPREAD FATIGUE DAMAGE
Shinozuka, M., Princeton Univ., USA; Deodatis, G., Princeton Univ., USA; Sampath, S. G., Federal Aviation Administration, USA; Asada, H., National Aerospace Lab., Japan; Dec. 1995; 12p; In English; See also 19960020736; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The purpose of the present study is to perform a Bayesian reliability analysis for developing appropriate non-periodic inspection schedules and estimating values of uncertain parameters from data collected during in-service inspections for practical aircraft structural elements. Fuselage structures for an aging aircraft with a number of fatigue-critical elements, having potential to produce widespread damage, are used as a realistic structural model for the analysis. Each element consisting of a skin panel and frames, is subjected to cyclic stress and is designed with the damage tolerance criterion. Probabilistic factors considered in this analysis are fatigue crack initiation and propagation, crack detection capability and failure rates before and after crack initiation. Numerical simulations are performed to demonstrate the efficacy of the Bayesian reliability analysis for the development of inspection schedule and for the estimation of the unknown model parameters.
Author
Fatigue (Materials); Damage Assessment; Bayes Theorem; Reliability Analysis; Aircraft Maintenance; Inspection; Schedules; Performance Prediction; Mathematical Models; Structural Analysis

19970019675 Daimler-Benz Aerospace A.G., Military Aircraft Div., Munich, Germany
QUALITY ASSURANCE AND CERTIFICATION PROCEDURES FOR BONDED JOINTS IN ON-AIRCRAFT SCENARIOS
Maier, A., Daimler-Benz Aerospace A.G., Germany; Gunther, G.,

Daimler-Benz Aerospace A.G., Germany; Jan. 1997; 10p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

As the repair of primary composite aircraft structures using composite materials has become a matter of 'world wide interest and activity', the requirement of certification methods and engineering standards for composite repairs have become evident. Bonded joints for principal load transfer within the structure have to run through an extensive certification/qualification procedure during development phase and are subject to rigorous quality control during the original component manufacturing. However, within typical 'On-Aircraft' repair scenarios bonding procedures and manufacturing conditions are in almost every technical aspect different from original processes and require therefore more extensive verification. Methods to certify repair design, repair procedures, repair methodology and quality control depend on specific repair levels (i.e SRM, Engineering Disposition, ABDR) and are yet standardised. The paper describes DASA's current approach to certify bonded repairs for damages which require 'Engineering Disposition' for 'On-Aircraft' application.

Author

Bonded Joints; Aircraft Structures; Composite Structures; Aircraft Maintenance; Quality Control

19970041544 R-Tec, Rolling Hills Estates, CA United States

VISUAL AND NON-DESTRUCTIVE INSPECTION TECHNOLOGIES

Ratwani, Mohan M., R-Tec, USA; Oct. 1996; 16p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper discusses currently available techniques for detecting damage in structures and their limitations. Inspection of cracks in substructure and hidden corrosion has always presented a nightmare fore NDI engineers. Some recent advances made in the NDI technology to solve these problems are discussed. Proper inspection at regular intervals is one technology area which plays an important role in the safety of flight of military and commercial aircraft. Reliable visual and nondestructive inspection (NDI) methods are needed to assure the airworthiness of these aircraft and at the same time keep maintenance costs to a minimum.

Derived from text

Aircraft Reliability; Substructures; Cracks; Damage; Inspection; Commercial Aircraft; Nondestructive Tests

19970041547 Federal Aviation Administration, Technical Center, Atlantic City, NJ United States

AIRFRAME INSPECTION RELIABILITY

Sampath, S. G., Federal Aviation Administration, USA; Oct. 1996; 10p; In English; See also 19970041535; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Inspection reliability is a cornerstone of the damage tolerance philosophy underlying the U. S. Air Force Airframe Structural Integrity Program (ASIP) and their Engine Structural Integrity Program (ENSIP), which are designed to ensure continued airworthiness of its fleet. Inspection data are essential to deriving inspection thresholds and inspection intervals; elements of every maintenance program for the constituents within a fleet. Frequency and the method of inspection are primary drivers of maintenance costs and thus life-cycle costs. On the other hand, structural safety also depends on inspection reliability, i.e., the ability to detect damage in a timely fashion. This presentation highlights certain aspects of inspection reliability that primarily relate to airframe structures and recommends the establishment of an international data collection and cataloging activity for improving inspection reliability.

Derived from text

Inspection; Tolerances (Mechanics); Aircraft Reliability; Aircraft Structures; Airframes; Life Cycle Costs; Structural Failure; Structural Stability; Costs; Damage

39
STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress. For applications see 05 Aircraft Design, Testing and Performance and 18 Spacecraft Design, Testing and Performance.

19960020739 NASA Langley Research Center, Hampton, VA United States

FRACTURE ANALYSIS OF STIFFENED PANELS UNDER BIAXIAL LOADING WITH WIDESPREAD CRACKING

Newman, J. C., Jr., NASA Langley Research Center, USA; Dawicke, D. S., Analytical Services and Materials, Inc., USA; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 16p; In English; See also 19960020736; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

An elastic-plastic finite-element analysis with a critical crack-tip-opening angle (CTOA) fracture criterion was used to model stable crack growth and fracture of 2024-T3 aluminum alloy (bare and clad) panels for several thicknesses. The panels had either single or multiple-site damage (MSD) cracks subjected to uniaxial or biaxial loading. Analyses were also conducted on cracked stiffened panels with single or MSD cracks. The critical CTOA value for each thickness was determined by matching the failure load on a middle-crack tension specimen. Comparisons were made between the critical angles determined from the finite-element analyses and those measured with photographic methods. Predicted load-against-crack extension and failure loads for panels under biaxial loading, panels with MSD cracks, and panels with various number of stiffeners were compared with test data, whenever possible. The predicted results agreed well with the test data even for large-scale plastic deformations. The analyses were also able to predict stable tearing behavior of a large lead crack in the presence of MSD cracks. The analyses were then used to study the influence of stiffeners on residual strength in the presence of widespread fatigue cracking. Small MSD cracks were found to greatly reduce the residual strength for large lead cracks even for stiffened panels.

Author

Cracks; Finite Element Method; Panels; Cracking (Fracturing); Failure Analysis; Crack Propagation; Aluminum Alloys; Rigid Structures

19960020742 Daimler-Benz Aerospace A.G., Fatigue and Damage Tolerance Dept., Hamburg, Germany

A CONCEPT FOR THE EVALUATION OF MSD BASED ON PROBABILISTIC ASSUMPTIONS

Horst, Peter, Daimler-Benz Aerospace A.G., Germany; Schmidt, Hans-Juergen, Daimler-Benz Aerospace A.G., Germany; Widespread Fatigue Damage in Military Aircraft; Dec. 1995; 12p; In English; See also 19960020736; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The present paper describes a general approach for the assessment of Multiple Site Damage (MSD), and as a subsequent phenomenon Widespread Fatigue Damage (WFD). A rough outline of the model used is presented. Furthermore, emphasize is put on the fact that a set of parameters will influence MSD as well as WFD, which all show a considerable probabilistic scatter. Some of those parameters are discussed in this paper; especially, the scatter of fatigue data. Manufacturing as well as deteriorating effects are discussed. Finally, an example indicates that the general line of the model works well.

Author

Damage Assessment; Fatigue (Materials); Probability Theory; Prediction Analysis Techniques; Mathematical Models; Monte Carlo Method; Applications Programs (Computers); Finite Element Method; Compounding; Stress Intensity Factors

19960021128 NASA Lewis Research Center, Cleveland, OH United States

STANDARDIZATION ACTIVITIES IN TMF TEST METHODOLOGIES

Verrilli, M. J., NASA Lewis Research Center, USA; Castelli, M. G., NYMA, Inc., USA; Bressers, J., Joint Research Centre of the European Communities, Netherlands; Oehmke, R. L. T., MTS Systems Corp., USA; Thermal Mechanical Fatigue of Aircraft Engine Materials;

Mar. 1996; 12p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

No standard test practice currently exists for strain-controlled thermomechanical fatigue (TMF) testing. This paper discusses recent activities which lay the foundation for standardization of TMF test methods. Specifically, the paper documents the results of two interlaboratory TMF test programs, identifies key TMF symposia and workshops, and discusses efforts toward drafting a TMF standard test practice.

Author

Fatigue Tests; Standardization; Thermal Fatigue; High Temperature Tests; Thermodynamic Properties; Stress-Strain Relationships

19960021129 Instituto Superior Tecnico, Lisbon, Portugal

ELEVATED TEMPERATURE FATIGUE OF IN718: EFFECTS OF STRESS RATIO AND FREQUENCY

Branco, C. Moura, Instituto Superior Tecnico, Portugal; Byrne, J., Portsmouth Polytechnic, UK; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 12p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The paper presents a combined analysis of the influence of stress ratio, frequency (hold time) on the fatigue crack growth in IN718 at 600 C. Fatigue crack growth rate (FCGR) data is presented for three stress ratio values (0.05, 0.5 and 0.8) and several values of hold time at maximum load ranging from 10 to 600s. FCGR data is also presented for sustained load where oxidation damage and creep failure mechanisms dominate. A preliminary assessment is presented of the transition frequency behavior from transgranular dominant cracks to intergranular dominant. SEM observations show that specific types of failure can occur for different combinations of stress ratio and frequency.

Author

High Temperature; Crack Propagation; Thermal Fatigue; Heat Resistant Alloys; Thermal Stresses; Stress Ratio

19960021130 Ecole Polytechnique Federale de Lausanne, Switzerland

NON-ISOTHERMAL FATIGUE: METHODS, RESULTS AND INTERPRETATION

Engler-Pinto, C. C., Jr., Ecole Polytechnique Federale de Lausanne, Switzerland; Blumm, M., Ecole Polytechnique Federale de Lausanne, Switzerland; Meyer-Olbersleben, F., Ecole Polytechnique Federale de Lausanne, Switzerland; Ilschner, B., Ecole Polytechnique Federale de Lausanne, Switzerland; Rezai-Aria, F., Ecole Polytechnique Federale de Lausanne, Switzerland; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 10p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Non-isothermal fatigue is one of the life limiting factors of the turbine blades in service. Thermal fatigue (TF) and thermomechanical (TMF) fatigue are two basic tests used for non-isothermal assessments of materials. In this investigation both TF and TMF tests are conducted. The mechanical strain at the wedge tip of blade-shaped TF specimens is measured as a function of temperature and applied as the basic TMF cycle. Crack initiation life and total life in TF and TMF are compared for CMSX-6. It is observed that the life under TF experiment is lower than TMF for the test conditions investigated. The effect of the thermal gradient fluctuation on the crack initiation life is reported for CM247LCDS. It is shown that a Miner's cumulative linear law can accommodate the effect of the variation of the thermal gradient on the remaining thermal fatigue life.

Author

Thermal Fatigue; Fatigue Life; Turbine Blades; Thermodynamic Properties; Crack Initiation; Thermodynamic Cycles

19960021131 Ecole des Mines de Paris, Evry, France

THERMAL FATIGUE: A USEFUL TOOL TO ASSESS LOW CYCLE FATIGUE DAMAGE IN SUPERALLOYS FOR COMPONENTS EXPERIENCING THERMAL TRANSIENTS

Koster, A., Ecole des Mines de Paris, France; Chataigner, E., Ecole des Mines de Paris, France; Remy, L., Ecole des Mines de Paris, France; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 8p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A thermal fatigue facility using a lamp furnace is described. This test is intended to simulate thermal shocks on a simple structure, and is shown to be a useful tool to investigate the damage evolution in superalloys exposed to temperature transients up to 1100 C. This is illustrated by the study of two nickel-based superalloys: a wrought superalloy used for rocket engine, and a single-crystal superalloy (AM1) used for jet engine blades. The effect of the specimen geometry and of a coating on fatigue life and failure mechanisms are described. Comparisons with thermal-mechanical fatigue results show the necessity of thermal fatigue tests for studying high temperature materials. A heat transfer analysis and a stress analysis are made for two geometries of wedge type specimens. The temperature history of the thin edge as well as the stress-strain hysteresis loops are so computed. These computations are used for lifetime prediction. In the case of the wrought superalloy, TF experiments are found in good agreement with lifetime predictions and TMF test results.

Author

Thermal Fatigue; Heat Resistant Alloys; Fatigue Tests; Thermodynamic Cycles; Furnaces; Thermal Shock; Damage Assessment; Engine Parts; Thermal Stresses; Stress-Strain Relationships

19960021132 Commission of the European Communities, Inst. for Advanced Materials., Petten, Netherlands

EFFECTS OF CYCLE TYPE AND COATING ON THE TMF LIVES OF CMSX6

Bressers, J., Commission of the European Communities, Netherlands; Timm, J., Commission of the European Communities, Netherlands; Affeldt, E., Motoren- und Turbinen-Union Muenchen G.m.b.H., Germany; Bennett, A., Rolls-Royce Ltd., UK; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 10p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Strain controlled thermo-mechanical fatigue cycles simulating the temperature-strain-time history at critical locations of blades of advanced aero gas turbines are applied to the single crystal nickel based alloy CMSX6 in the uncoated and PtAl coated conditions. The TMF cycle selection includes a 135 deg lag cycle and an in-phase cycle, with various R(sub epsilon)-ratios, T(sub min)=300 C, and T(sub max)=1050 C and 850 C, respectively. The cycle-specific stress response is analyzed and discussed in terms of the accumulation of inelastic strain during the TMF tests. The number of cycles for initiating microcracks is measured by means of a computer vision system. Various modes of crack initiation and crack growth are observed and correlated with the TMF cycle type, with the strain range imposed, and with the ductile/brittle behaviour of the coating. The differences in TMF lives are discussed in terms of the material and TMF parameters.

Author

Thermodynamic Cycles; Protective Coatings; Fatigue Life; Thermal Fatigue; Turbine Blades; Nickel Alloys; Crack Initiation; Crack Propagation

19960021134 ABB Corporate Research Centre, Heidelberg, Germany

DEFORMATION AND FAILURE MECHANISMS OF DS CM 247 LC UNDER TMF AND LCF LOADING

Sommer, C., ABB Corporate Research Centre, Germany; Bayerlein, M., ABB Corporate Research Centre, Germany; Hartnagel, W., ABB Corporate Research Centre, Germany; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 12p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The deformation, crack initiation and crack propagation behavior of DS CM 247 LC in longitudinal and transverse orientation under LCF loading at 500 C to 1000 C and TMF loading (400-1000 C out-of-phase cycle) is described in this paper and discussed under the aspect of TMF life time prediction. Different deformation and damage mechanisms were found for low temperature LCF, high temperature LCF and TMF loading. The deformation and damage behavior under TMF loading incorporates characteristics typical for low temperature LCF as well as characteristics typical for high temperature LCF. Cutting of (gamma)' as well as interfacial network formation is observed. Cracks were found to initiate at strongly oxidized carbides similar to what is observed under high temperature LCF, the crack propagation however is a mixture of crystallographic and noncrystallographic crack growth. Cyclic plastic deformation at low temperatures (under low temperature LCF as well as under TMF loading) was found to be very detrimental. The coincidence between TMF life data and LCF life data at a temperature close to the upper temperature of the TMF cycle on a total strain

and equal strain rate basis maybe related to the oxidation controlled crack initiation mechanism which is identical for both types of loading or has to be regarded as fortuitous.
Author
Fatigue Tests; Fatigue Life; Thermal Stresses; Thermal Fatigue; Failure Modes; Plastic Deformation; Crack Propagation

19960021140 Ecole Polytechnique, Montreal, Quebec Canada
MODELLING OF THERMOMECHANICAL FATIGUE INCLUDING PHASE TRANSFORMATIONS
Boire-Lavigne, S., Ecole Polytechnique, Canada; Gendron, S., Ecole Polytechnique, Canada; Marchand, N. J., AMRA Technologies, Canada; Immarigeon, J. P., National Research Council of Canada, Canada; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 10p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Typical gas turbine and jet engine hot section components are subjected to severe environment along with variable thermal and mechanical loading histories. Furthermore, stress induced morphological transformations of the materials have been observed to occur during turbine engine operations with the amount of transformation a function of the thermal-mechanical history. At present, the popular models for thermal-mechanical fatigue (TMF) life predictions are based on creep-fatigue interactions and do not explicitly contain environmental and microstructural transformation features. In this paper, a novel framework and process simulation software, which explicitly tracks the evolution of the microstructure (including dislocations structures) is presented. In essence, this model described the overall behavior of a material as the weighted average of the mechanical responses of the present phases (or dislocation structures). Dynamic recovery is modeled by explicitly describing the transformations of a 'hard structures' to a 'soft structure' in agreement with the basics concepts of dislocations dynamics. The effectiveness of this novel multistructure approach will be demonstrated through modeling the TMF behavior of Rene 80.
Author
Thermal Fatigue; Phase Transformations; Thermodynamic Properties; Microstructure; Dynamic Response; Nickel Alloys; Heat Resistant Alloys; Models

19960021141 Wright Lab., Materials Directorate., Wright-Patterson AFB, OH United States
FATIGUE CRACK GROWTH UNDER TMF
Nicholas, T., Wright Lab., USA; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 10p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The use of a linear damage summation approach for the prediction of crack growth rates under thermomechanical fatigue (TMF) is summarized. The methodology involves the addition of growth rates due to cyclic and time-dependent mechanisms. In creep-brittle materials, the summation approach is straightforward when applied to TMF. For creep-ductile materials, the retardation of the crack growth rate due to crack tip blunting, branching, or stress relaxation, has to be taken into account. This is accomplished through the use of a blunting coefficient with its own evolution equations. The methodology is applied to TMF crack growth in a titanium matrix composite by modifying the functional form of the two terms. The cycle-dependent term is taken as a function of temperature, while the time-dependent term has a slight Delta-K dependence coupled with the integral of an Arrhenius type term over an entire cycle. For all three materials, the modeling approach provides reasonable predictions of TMF crack growth rates based solely on parameters obtained from isothermal test data.
Author
Crack Propagation; Thermodynamic Properties; Thermal Fatigue; Creep Properties; Damage Assessment; Metal Matrix Composites; Temperature Dependence; Ductility

19960021142 Federal Inst. for Materials Research and Testing, Berlin, Germany
THERMO-MECHANICAL BEHAVIOR OF IN 738 LC AND SC 16
Meersmann, J., Federal Inst. for Materials Research and Testing, Germany; Frenz, H., Federal Inst. for Materials Research and Testing, Germany; Ziebs, J., Federal Inst. for Materials Research and Testing, Germany; Kuhn, H.-J., Federal Inst. for Materials Research and Testing, Germany; Forest, S., Federal Inst. for Materials Research and Testing, Germany; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 12p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This article describes the study of uniaxial and biaxial thermomechanical fatigue (TMF) response of IN 738 LC and the initial experiments of single crystal superalloy SC 16. A life prediction assessment is proposed based on the inelastic work Sigma sigma(sub ij) Delta Sigma(sup in, sub ij) at N(sub f)/2. It is shown that the J(sub 2)-theory is applicable to TMF loadings. Initial experiments on single crystal superalloy SC 16 prove that there is a non-uniform strain distribution in the plastic region along the circumference of (001) oriented specimens. These findings must be weighed when performing TMF-tests.
Author
Heat Resistant Alloys; Thermal Stresses; Fatigue Life; Prediction Analysis Techniques; Thermal Fatigue; Thermodynamic Properties

19960021143 United Technologies Corp., West Palm Beach, FL United States
TMF LIFE PREDICTION APPROACH FOR TURBINE BLADES
Heine, J. E., United Technologies Corp., USA; Ruano, E., United Technologies Corp., USA; DeLaneuville, R. E., United Technologies Corp., USA; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 6p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Extreme temperature gradients and transients thermally induce the most severe cyclic stresses encountered by turbine airfoils. These thermal stresses combine with mechanically induced centrifugal and bending loads to produce thermomechanical fatigue (TMF) of the airfoil. Anisotropic material properties of advanced turbine blade alloys further complicate analysis and life prediction for these complex loading conditions. Designers and engineers require quick, efficient computational analysis to evaluate airfoil design iterations. A life prediction approach which can be utilized efficiently by designers needs to be relatively simple, but it must capture the first order TMF effects. This paper introduces a life prediction approach that utilizes 3D finite element output and applies a simplified constitutive model to predict the stress extremes of a TMF cycle in an advanced single crystal alloy. An appropriate TMF life relation, such as hysteretic energy, can be use to predict cyclic life.
Author
Fatigue Life; Service Life; Thermal Fatigue; Turbine Blades; Thermal Stresses; Prediction Analysis Techniques; Finite Element Method; Three Dimensional Models; Stress Analysis

19960021144 General Electric Co., Aircraft Engines., Cincinnati, OH United States
ELEVATED TEMPERATURE COMPONENT FATIGUE ROBUSTNESS: AN HOLISTIC APPROACH
Domas, P. A., General Electric Co., USA; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 14p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Fundamental material behavior research in thermal mechanical cycling environments is obviously essential to eventual development and use of thermal mechanical fatigue (TMF) life models in component durability assessments. However, the scope of the research should be guided and focused by experience and issues encountered in actual product usage. Crack nucleation at surface intersecting ceramic inclusions and degraded low cycle fatigue (LCF) capability of thermally exposed shot peened surfaces are two elements of potential importance to more accurate TMF life prediction of powder metal (PM) nickel base superalloy turbine engine components. Both temperature dependent effects, identified and evaluated in a comprehensive alloy development program, provide significant challenge to conventional, applied engineering fatigue life prediction methodologies. But, nevertheless, such influences must be recognized in design, component manufacture, and field life management. An overview of observed material fatigue behavior provides an industry example as a basis to illustrate the importance, necessity, and benefit of a fully integrated (holistic) design, material processing, and component manufacturing system approach to obtaining desired product robustness.
Author
Temperature Dependence; Thermal Cycling Tests; Heat Resistant Alloys; Metal Powder; Engine Parts; Metal Fatigue; Thermal Fatigue; Engine Design; Robustness (Mathematics); Thermal Stresses

19960021145 Forschungszentrum Juelich G.m.b.H., Juelich, Germany
THERMAL MECHANICAL FATIGUE OF MODEL BLADES MADE FROM CC AND DS SUPERALLOYS
Schubert, F., Forschungszentrum Juelich G.m.b.H., Germany; Penkalla, H. J., Forschungszentrum Juelich G.m.b.H., Germany; Frank, D., Forschungszentrum Juelich G.m.b.H., Germany; Thermal Mechanical Fatigue of Aircraft Engine Materials; Mar. 1996; 14p; In English; See also 19960021124; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Thermal mechanical tests with internally cooled model blades of IN 783 LC (conventional casted) and of IN 792 DS (directionally solidified) are experiments to develop non linear elastic analysis methods of stress strain behavior and life time estimation methods. For the inelastic analysis, a constitutive equation has been developed. This constitutive equation describes the deformation behavior by using internal variables which concern microstructural features. The constitutive equation has been implemented user materials routines (UMAT) in the finite element code ABAQUS. In the experiment with model blades, loaded periodically in simulating loading cycle of a real working blade for large stationary gas turbine, the temperature distribution are measured by a set of thermal couples around the blade and calculated with using heat transfer estimations for the impact of heat by a high frequency induction coil and heat consumption by the cooling air. Based on the calculated temperature distribution the stress strain behavior for different point was computed and as far as possible compared with measured strains. The comparison of experimental results with the mathematical prediction showed a fair conformaty.
Author
Thermal Fatigue; Heat Resistant Alloys; Stress-Strain Relationships; Turbine Blades; Thermal Stresses; Stress Analysis; Thermodynamic Cycles

19970001704 Sheffield Univ., Dept. of Mechanical Engineering, United Kingdom
ACTIVE AND PASSIVE DAMPING TECHNIQUES
Tomlinson, G. R., Sheffield Univ., UK; Rongong, J., Sheffield Univ., UK; Smart Structures and Materials: Implications for Military Aircraft of New Generation; Oct. 1996; 6p; In English; See also 19970001697; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The use of passive and active damping techniques for minimizing structural vibration is discussed. It is shown that passive damping, employing constrained viscoelastic layers requires careful consideration in terms of frequency and temperature in order to optimize the performance and that at high frequencies, the combination of longitudinal, flexural and radial modes can significantly modify the performance. When active methods are employed, dramatic improvements in the effective damping can be obtained and if this is combined with constrained viscoelastic materials, even greater improvements are found. This paper concludes with an overview of the concepts currently being applied and how Smart technologies should lead to effective solutions.
Author
Damping; Structural Vibration; Optimization; Active Control

19970001705 Sheffield Univ., Dept. of Mechanical Engineering, United Kingdom
A NOVEL APPROACH TO STRUCTURAL DESIGN USING BIOLOGICAL MODELS
Wardle, R., Sheffield Univ., UK; Tomlinson, G. R., Sheffield Univ., UK; Oct. 1996; 8p; In English; See also 19970001697; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Methods of adapting the placement and properties of material within structures subject to static and dynamic loading are presented. It is shown that for a statically loaded cantilever a spatially local adaptation process can produce a structure which has a topology and material properties much improved from the original. For a dynamically excited structure an evolutionary method is used to add free-layer damping to the surface of the structure, reducing the amplitude of vibration while minimizing the mass of additional damping material.
Author
Smart Structures; Shape Memory Alloys; Dynamic Loads; Static Loads; Vibration Damping; Cantilever Beams

19970010680 Instituto Superior Tecnico, Lisbon, Portugal
TOPOLOGY OPTIMISATION OF 3D LINEAR ELASTIC STRUCTURES
Fernandes, P. R., Instituto Superior Tecnico, Portugal; Rodrigues, H., Instituto Superior Tecnico, Portugal; Guedes, J. M., Instituto Superior Tecnico, Portugal; Oct. 1996; 10p; In English; See also 19970010666
Contract(s)/Grant(s): AGARD Proj.86 (SMP/ASP31); JNICT Proj.PRAXIS 3/3.1/CTM/10; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

In its most general form, the topology optimization problem of structures can be viewed as the process of identifying the characteristic (indicator) function of the domain occupied by the optimal structure. Such a topology design problem is an integer programming problem (material/no material), which is difficult to solve directly and may be ill-posed. One of the methods used to overcome these difficulties is to relax the problem by introducing a material volume fraction parameter that has a continuous variation from zero to one. In engineering applications, the relaxation is done introducing either a material model with microstructures, where the material properties are computed by the homogenization method, or via an artificial, generally a polynomial, dependence between the mechanical properties and the material volume fraction. Usually the obtained optimal (final) topology, which use the material distribution approach, does not characterize a well defined structure, i.e., it has regions with porous material and/or with checkerboard patterns. Also, it has been observed that the final topology is not stable with the finite element mesh refinement. The goal of the perimeter constraint is to overcome these problems. This work presents the development of a computational model for the topology optimization of a three dimensional linear elastic structure using the material distribution approach. The optimization criterion is the structural compliance, subjected to an isoperimetric constraint on volume and a constraint on the structural perimeter. The necessary conditions for optimum are derived analytically. These conditions are treated numerically through a suitable finite element discretization and solved by a first order method based on the optimization problem Augmented Lagrangian. The computational model developed is tested and analyzed in several numerical applications.
Author
Topology; Mathematical Models; Elastic Properties; Finite Element Method; Three Dimensional Models; Structural Analysis; Lagrangian Function

19970019656 Dayton Univ. Research Inst., OH United States
STRESS ANALYSIS OF OPEN AND FASTENER HOLE COMPOSITES BASED ON THREE-DIMENSIONAL SPLINE VARIATIONAL TECHNIQUE
Iarve, Endel V., Dayton Univ. Research Inst., USA; Schaff, Jeffery R., Wright Lab., USA; Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 12p; In English; See also 19970019652
Contract(s)/Grant(s): F33615-95-D-5029; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A three-dimensional stress analysis method has been developed and verified for open and fastener hole laminated composites. This method is based on independent spline approximation of displacement and interlaminar stress components. Spline approximation offers continuity of displacement, strain and stress fields within homogeneous domains, preserving at the same time the advantages of local approximation, such as sparcity of the resulting system of equations. Verification of the spline approximation solution for a fiber dominated 28 ply, IM7/5250-4, laminate with an open hole was performed through comparisons with experimentally obtained surface strain measurements using the moire interferometry technique. For the filled hole case, the contact problem describing the interaction between a composite plate with a circular hole and an elastic fastener has been solved with three-dimensional spline approximation of displacements and using the Lagrangian multiplier method. Direct comparisons are made with an asymptotic solution of the three body contact problem appearing at the elastic fastener hole edge in a composite laminate. Good agreement between the singular term of the asymptotic solution and spline variational solution for all stress components was observed

in the open and filled hole tension problems. The power of singularity at a +/- 45 ply interface in a (+/- 45)(sub s) AS4/3501-6 laminate with a filled hole was calculated for different stiffnesses of the fasteners.
Author
Stress Analysis; Fasteners; Holes (Mechanics); Splines; Plates (Structural Members); Laminates; Interlaminar Stress

19970019657 Daimler-Benz Aerospace A.G., Munich, Germany
DEVELOPMENT OF A STRESSING METHOD FOR BOLTED JOINTS
Bauer, J., Daimler-Benz Aerospace A.G., Germany; Mennle, E., Daimler-Benz Aerospace A.G., Germany; Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 10p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper describes the various steps for the development of a stressing method for bolted joints in Polymeric Composites. First a semi-empirical analysis was generated correlating test results and the corresponding analytical data. Subsequently this predictive technique was used to derive carpet plots and diagrams which then form the basis for the stressing method. In order to cover arbitrary loading conditions the information from the diagrams is incorporated into an algorithm for final determination of the laminate strength.
Author
Bolted Joints; Laminates; Stress Analysis; Stress Measurement

19970019658 Imperial Coll. of Science Technology and Medicine, Center for Composite Materials, London, United Kingdom
DEVELOPMENT OF FAILURE IN BOLTED JOINTS IN WOVEN CFRP LAMINATES
Oakeshott, J. L., Imperial Coll. of Science Technology and Medicine, UK; Gower, M., Imperial Coll. of Science Technology and Medicine, UK; Perinpanayagam, S., Imperial Coll. of Science Technology and Medicine, UK; Matthews, F. L., Imperial Coll. of Science Technology and Medicine, UK; AGARD Conference Proceeding: Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 12p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A recent project at Imperial College was concerned with the development of finite element procedures for predicting the failure of bolted joints in composite laminates. Both 2-D and 3-D analyses were undertaken, one objective of the latter being to correlate the stress distributions around a fastener with the failure modes observed experimentally. In support of the FE work an extensive test programme was carried out on single fastener joints loaded at increasing fractions of the ultimate load. The nominally 2mm thick laminates were fabricated from prepreg which consisted of balanced satin weave fabric impregnated with epoxy resin. For each load level specimens were dissected and examined under an optical microscope. A 'map' of damage growth was obtained for specimen configurations exhibiting either bearing or net tensile failure. The principal failure modes observed were fibre microbuckling and through-thickness matrix shear cracking.
Author
Polymer Matrix Composites; Epoxy Resins; Bolted Joints; Fiber Composites; Finite Element Method; Laminates

19970019659 McGill Univ., Dept. of Mechanical Engineering, Montreal, Quebec Canada
THREE-DIMENSIONAL PROGRESSIVE FAILURE ANALYSIS OF PIN/BOLT LOADED COMPOSITE LAMINATES
Shokrieh, M. M., McGill Univ., Canada; Lessard, L. B., McGill Univ., Canada; Poon, C., National Research Council of Canada, Canada; Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 10p; In English; See also 19970019652
Contract(s)/Grant(s): DNDFE-220794NRC08; NRC Proj. 3G3; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A new phenomenological modeling technique, called fatigue progressive damage modeling, was established. This new modeling technique is capable of predicting the residual strength, residual stiffness, and fatigue life of pin/bolt loaded composite laminates. Stress analysis, failure analysis, and material property degradation rules are the three major components of the model. A three-dimensional, nonlinear, finite element technique was used for the stress analysis. Based on the state of stress, different failure modes were detected by a set of failure criteria. to remove the requirement of a large experimental database for the failure analysis, a normalization technique was adopted. By using this technique the restriction of the application of the failure criteria to limited states of stresses was overcome Material properties of each element in the model were degraded by using sudden and gradual material property degradation rules. For this purpose an analytical model was established to predict the degradation of material properties of a unidirectional ply under multiaxial fatigue loading. Based on the model, a computer code was developed that simulates cycle by cycle behavior of composite laminates under fatigue loading. The modeling technique uses experimental data from a unidirectional ply under various types of uniaxial loading to predict the behavior of structures subjected to multiaxial fatigue loading. Fatigue testing of pin/bolt loaded composite laminates was performed to validate the modeling technique.
Author
Bolts; Bolted Joints; Stress Analysis; Stiffness; Residual Strength; Pins; Phenomenology; Laminates; Finite Element Method; Fatigue Life; Fatigue (Materials); Failure Modes

19970019660 McDonnell-Douglas Corp., Long Beach, CA United States
ANALYSIS METHOD FOR BOLTED COMPOSITE JOINTS SUBJECTED TO IN-PLANE SHEAR LOADS
Hart-Smith, L. J., McDonnell-Douglas Corp., USA; Jan. 1997; 12p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

New analysis methods are developed for predicting the strength of bolted joints in fibrous composite laminates for geometries other than the standard test coupons, particularly in regard to in-plane-shear loads. The methods build on the author's earlier works, using the same technique of accounting for the stress-concentration relief permitted by the heterogeneous nature of fibre-polymer composites Similar linear bearing/bypass curves, terminated by a bearing-stress cut-off, are predicted for these new joint geometries. The interactions have the same form as those which are now well accepted for the conventional case of parallel bearing and bypass loads, only with different slopes. The theory has been developed ahead of any relevant test data in the hope of encouraging an appropriate test program, so that these new solutions could be validated or refined and then added to existing joint-analysis computer codes with appropriate boundary conditions and failure criteria.
Author
Bolted Joints; Composite Structures; Composite Materials; Stress Concentration; Laminates; Fiber Composites

19970019661 National Research Council of Canada, Inst. for Aerospace Research; Structures, Materials and Propulsion Lab., Ottawa, Ontario Canada
STRESS AND FAILURE ANALYSIS OF BONDED COMPOSITE-TO-METAL JOINTS
Xiong, Y., National Research Council of Canada, Canada; Raizenne, D., National Research Council of Canada, Canada; Bolted/Bonded Joints in Polymeric Composites; Jan. 1997; 12p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The behavior of bonded composite-to-metal joints is examined based on the results of stress analysis and failure prediction using a quasi two-dimensional analytical model. Two joint configurations are considered which simulate the problems of bonded composite patch repair such as fatigue enhancement and crack patching. The metallic substrate is of uniform thickness, while the composite patch has a tapered region at its edges. Several typical failure modes associated with the adherends and adhesive are considered including substrate yielding, adhesive shearing, interface peeling, patch fiber breaking, patch ply shearing and patch ply peeling. The effects of the thermal residual stresses after curing on the load transfer between the adherends are discussed. Various geometric configurations are examined from an optimal design point of view.
Author
Bolted Joints; Adhesive Bonding; Bonded Joints; Metal Joints; Residual Stress; Shearing; Stress Analysis; Thermal Stresses

19970019662 Imperial Coll. of Science Technology and Medicine, Mechanical Engineering Dept.; Center for Composite Materials, London, United Kingdom
STRENGTH PREDICTION OF BONDED JOINTS
Charalambides, M. N., Imperial Coll. of Science Technology and Medi-

cine, UK; Kinloch, A. J., Imperial Coll. of Science Technology and Medicine, UK; Matthews, F. L., Imperial Coll. of Science Technology and Medicine, UK; Jan. 1997; 10p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The performance of carbon fiber/epoxy repair joints bonded with an epoxy film adhesive, under static and fatigue loading has been investigated. The joints have been immersed in water at 50?C for a period of 16 months and the effect of the hot/wet environment on the static and fatigue strengths was evaluated. In addition, residual strength tests, i.e. static tests of pre-fatigued repair joints were performed. The mechanical properties of the substrate and the adhesive forming the joint were also determined. Apart from the experimental study, it was also desirable to determine a failure criterion which will accurately predict the experimental strength of this joint. A parallel study on double lap joints prepared from the same substrate and adhesive as the repair joints, was performed. Static tests on lap joints of various overlap lengths were conducted. The experimental failure loads were used in conjunction with finite element analysis to examine the validity of proposed failure criteria.

Author

Bonded Joints; Residual Strength; Static Tests; Static Loads; Lap Joints; Finite Element Method; Fiber Composites; Epoxy Resins; Epoxy Matrix Composites; Carbon Fibers; Adhesives; Adhesive Bonding

19970019663 Aachener Centrum fuer Erstarrung unter Schwerelosigkeit e.V., Germany

NUMERICAL STRENGTH PREDICTIONS OF ADHESIVELY BONDED MULTIMATERIAL JOINTS

Laschet, G., Aachener Centrum fuer Erstarrung unter Schwerelosigkeit e.V., Germany; Jan. 1997; 16p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Numerical tools have been developed in order to improve the strength prediction of adhesively bonded multimaterial joints. At first, a specific elastoplastic model based on the Raghava yield criterion is introduced for adhesives. Furthermore, in order to evaluate the strength reserve of a joint after local failure initiation, a simple smeared 2-D and 3-D crack propagation model is developed. Then, to improve this simple failure model, a new isotropic damage model for adhesives is presented, which is coupled with the specific elastoplastic one. Finally, the accuracy of this approach is illustrated by numerical strength and failure mode predictions of several single and double-lap joints.

Author

Adhesive Bonding; Bonded Joints; Elastoplasticity; Predictions; Numerical Analysis; Failure Modes

19970019666 Defence Research Agency, Structural Materials Centre, Farnborough, United Kingdom

CYCLIC FATIGUE AND ENVIRONMENTAL EFFECTS WITH ADHESIVELY BONDED JOINTS

Ashcroft, I. A., Defence Research Agency, UK; Gilmore, R. B., Defence Research Agency, UK; Shaw, S. J., Defence Research Agency, UK; Jan. 1997; 10p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The influence of service environment, bonding method and adherend properties on the fatigue resistance of adhesive bonded CFRP joints has been investigated. It was seen that environment had a significant effect on joint performance with hot/wet conditions proving extremely damaging. Composite lay-up also had a significant effect on the fatigue performance of joints and co-bonding was seen as an advantageous joining technique.

Author

Adhesive Bonding; Bonded Joints; Carbon Fiber Reinforced Plastics; Fatigue (Materials); Cyclic Loads

19970019670 Alenia Spazio S.p.A., Turin, Italy

AN INVESTIGATION ON A BOLTED-COLD BONDED JOINT FOR LARGE DIAMETER STRUCTURES

Montabone, M., Alenia Spazio S.p.A., Italy; Nebiolo, M., Alenia Spazio S.p.A., Italy; Vigada, C., Alenia Spazio S.p.A., Italy; Jan. 1997; 12p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A study is hereafter described to investigate the structural behavior of cold bonded/bolted and simply cold bonded joints. These joints are representative of connections at the interface of large diameter structures (over 4 m) in which sandwich composite panels have to be fixed to aluminium fork-shaped rings. They find practical application as adaptor structures for satellite launchers, providing high strength/stiffness performances, and are peculiar of areas fitted with continuous separation systems. Special low preload bolts have been introduced in order to avoid the use of through inserts in sandwich panels necessary to prevent the crushing of the core so optimizing mass and manufacturing cost/time but still maintaining very high load capabilities. A Finite Element analysis has been carried out to detect load distributions at the bolted/bonded interfaces of the joints. A test campaign is planned for the manufactured specimens and a final test correlation will be performed to compare experimental and theoretical results.

Author

Bolted Joints; Bonded Joints; Composite Structures; Finite Element Method; High Strength; Loads (Forces); Prestressing; Sandwich Structures

19970019672 British Aircraft Corp., London, United Kingdom

DESIGN LOADS FOR BONDED AND BOLTED JOINTS

Broome, M. J., British Aircraft Corp., UK; Jan. 1997; 14p; In English; See also 19970019652; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The conclusions of this report are that: detailed stress calculations methods for bonded and bolted joints require the input of accurate loads; the overall stiffness of honeycomb panels and bolted joints must be correctly represented in Fe models; and local non-linear effects should be considered in honeycomb panel ramps.

Derived from text

Bolted Joints; Bonded Joints; Honeycomb Structures; Loads (Forces)

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EARTH RESOURCES AND REMOTE SENSING

19950026717 Institute for Precision Instrumentation, Moscow, Russia

IDENTIFICATION OF TERRAIN IMAGERY WITH UNSTABLE REFLECTIVITY

Kozko, Y. A., Institute for Precision Instrumentation, Russia; Saveliev, V. V., Institute for Precision Instrumentation, Russia; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 7 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper deals with a problem of comparing two terrestrial images: the observed one obtained with a known device and the reference one that is an idealized picture of a given object. The whole problem is formulated in terms of statistical object identification. The SAR (Synthetic Aperature Radar) imagery main properties based on the analysis of experimental data are pointed out. A zonal SAR image model, signal fluctuation fluctuation statistics, number of looks, S/N ratio and natural cover fragmentation of terrestrial surfaces is proposed. Based on this model, the adaptive zonal recognition algorithms are built. Their efficiency has been confirmed experimentally in a wide range of zone contrasts and under various seasonal/weather conditions.

Derived from text

Images; Mathematical Models; Pattern Recognition; Pattern Registration; Radar Imagery; Reflectance; Synthetic Aperture Radar; Terrain

19960007227 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States

STRUCTURE, VARIABILITY, AND SENSING OF THE COASTAL ENVIRONMENT

Richter, Juergen H., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 14 p; In English; See also 19960007226; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Radar observations of coastal atmospheric structures and propagation data are presented to illustrate temporal and spatial variability of the propagation environment. Sensing of radio refractivity has historically been accomplished with direct sensing techniques such as

radiosondes. While direct sensing techniques provide good data for propagation assessment purposes, remotely sensed data would be more desirable. Various direct and remote sensing techniques and an assessment of their potential operational usefulness are reviewed. Included are radiosondes, refractometers, radar sounders, lidars, satellite-based sensors, and radiometric and radio propagation techniques. The need for and feasibility of providing three-dimensional, time-varying refractivity fields for propagation assessment are addressed. Aerosol extinction is often the atmospheric parameter limiting electrooptical systems performance. For proper performance assessment, slant path extinction must be known. For several decades, attempts have been made to infer aerosol extinction from lidar backscatter measurements. A discussion of selected lidar techniques and their limitations is presented.
Author
Coastal Water; Coasts; Marine Environments; Radar Measurement; Radar Tracking; Radio Transmission; Refractivity; Variability; Wave Propagation

19960007233 Rutherford Appleton Lab., Chilton, United Kingdom
FAST PE MODELS FOR MIXED ENVIRONMENTS
Levy, M. F., Rutherford Appleton Lab., UK; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 6 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

We derive non-local boundary conditions (NLBC's) for use with PE (parabolic equation) methods to compute the coverage diagram of surface or airborne sensors. With these boundary conditions, the PE integration domain can be truncated in height, with large savings in execution times. One of our NLBC's can be applied even when the source is above the domain of interest: this provides an efficient tool for computing the coverage diagram of an airborne source. The truncated PE method has been validated against traditional PE techniques, and should provide a robust and fast way of predicting propagation effects in complex environments for both surface and airborne sensors.
Author
Antenna Radiation Patterns; Atmospheric Effects; Boundary Conditions; Mathematical Models; Parabolic Differential Equations

19960007240 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States
RADIANCE OF THE OCEAN HORIZON
Zeisse, C. R., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 9 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

In 1954 Cox and Munk used aerial photographs of sun glint to determine the statistical distribution of ocean capillary wave slopes as a function of wind velocity. When their equation connecting the slope distribution with sun glint is used on the horizon, however, an infinite glint is predicted even though it can easily be shown that sun glint should never exceed solar radiance. This paper derives an integral equation which connects the capillary wave slope distribution with ocean radiance. It predicts a finite sun glint on the ocean horizon and the proper value of sun glint in the calm sea limit. Away from the horizon an approximation reduces this integral to the algebraic equation used by Cox and Munk.
Author
Capillary Waves; Glint; Ocean Surface; Oceans; Radiance; Sunlight; Water Waves; Wind Velocity

19970006887 Advisory Group for Aerospace Research and Development, Sensor and Propagation Panel, Neuilly-Sur-Seine, France
REMOTE SENSING: A VALUABLE SOURCE OF INFORMATION *LA TELEDETECTION: SOURCE PRECIEUSE DE RENSEIGNEMENTS*
Oct. 1996; 433p; In English; In French; Sensor and Propagation Panel Symposium, 22-25 Apr. 1996, Toulouse, France; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19970006888 through 19970006934; Original contains color illustrations
Report No.(s): AGARD-CP-582; ISBN 92-836-0032-0; Copyright Waived; Avail: CASI; A19, Hardcopy; A04, Microfiche

Remote sensing, either from satellites, airplanes, or remotely piloted vehicles (RPV's) can be used to obtain information from virtually all areas in the world. A wealth of information is relatively easily (and relatively cheaply) available from sensor systems in civil satellites, but this availability could decrease during times of increasing political tension. Cooperative programs must be encouraged to extract the required military information from unclassified civil sources. This symposium provides a platform for discussion between civil institutes, active in the area of remote sensing equipment, data handling, and processing on the one hand, and those who are involved in military applications on the other hand. The topics covered include: sensor systems; platforms; propagation effects; signal processing; military aspects; special civil applications; special techniques; and future developments.
Derived from text
Military Technology; Remote Sensing; Remotely Piloted Vehicles; Military Operations; Commercial Spacecraft

19970006888 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Optoelectronics, Berlin, Germany
SPACEBORNE OPTICAL REMOTE SENSING
Lanzl, Franz, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Remote Sensing: A Valuable Source of Information; Oct. 1996; 2p; In English; See also 19970006887; Copyright Waived; Avail: Issuing Activity; Abstract Only; Abstract Only

The combined high resolution stereo-multispectral opto-electronic camera MOMS was flown on the Shuttle D2 mission in 1993 and will be operating for about two years in the framework of the Priroda/MIR mission to be launched in April 1996. Mission objectives, data evaluation, application examples including digital terrain model derivation are presented. Plans for a near term operational high resolution optical Earth observation system based on the MOMS development are discussed.
Author
Cameras; Earth Observations (From Space); Remote Sensing; Space Missions; High Resolution; Multispectral Photography

19970006889 Politecnico di Milano, Dipartimento di Elettronica e Informazione, Milan, Italy
POSSIBILITIES AND LIMITS OF SAR INTERFEROMETRY
Rocca, Fabio, Politecnico di Milano, Italy; Prati, Claudio, Politecnico di Milano, Italy; Guarnieri, Andrea Monti, Politecnico di Milano, Italy; Remote Sensing: A Valuable Source of Information; Oct. 1996; 14p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this presentation we summarize the impact of interferometry on the design of synthetic aperture radar (SAR) surveys, its possibilities and limits. From the fringes a very good DEM is obtainable, with a vertical resolution that could be in the meter range or even less from airborne platforms. Millimetric motion of large areas of the terrain or of corner reflectors can be measured with good reliability and therefore the possibility of using the system to measure subsidence, landslides, coseismic motions has been demonstrated. The coherence of the interferometric pair is an important clue, that combined with the more usual backscatter amplitude, leads to high quality image segmentation. The wavenumber shift concept is finally introduced that may lead to a 3 dimensional view of the terrain. The same principle can be invoked to improve the resolution of objects that do not change with time.
Author
Synthetic Aperture Radar; Remote Sensing; Terrain Analysis; Imaging Techniques; Interferometry; High Resolution; Earth Observations (From Space)

19970006890 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Physics and Electronics Lab., The Hague, Netherlands
SAR SYSTEMS AND RELATED SIGNAL PROCESSING
Hoogeboom, P., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Dekker, R. J., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Otten, M. P. G., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Remote Sensing: A Valuable Source of Information; Oct. 1996; 6p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Synthetic Aperture Radar (SAR) is today a valuable source of remote sensing information. SAR is a side-looking imaging radar and

operates from airborne and spaceborne platforms. Coverage, resolution, and image quality are strongly influenced by the platform. SAR processing can be performed on standard computers or dedicated hardware architectures, depending on required throughput and image quality. Besides imaging, SAR can perform other modes of operation and applications such as multi-frequency and polarimetric imaging, elevation mapping, and moving target identification (MTI). Current developments in SAR systems are concentrated on higher resolution and flexibility in performing advanced modes in the future.
Author
Image Resolution; Side-Looking Radar; Synthetic Aperture Radar; Signal Processing; Remote Sensing; Airborne Radar

19970006891 Defence Research Establishment Ottawa, Aerospace Radar and Navigation, Ottawa, Ontario Canada
SPOTLIGHT SYNTHETIC APERTURE RADAR: SYSTEM OVERVIEW AND APPLICATION TO THE MARITIME AND LAND ENVIRONMENTS
Damini, Anthony, Defence Research Establishment Ottawa, Canada; Haslam, George E., Defence Research Establishment Ottawa, Canada; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Spotlight Synthetic Aperture Radar (SSAR) is a research and development project to develop the technology to retrofit the AN/APS-506 search radar on Canada's CP-140 maritime patrol aircraft with synthetic aperture radar (SAR) imaging modes. Three SAR modes have been developed: strip map mode in which the antenna is pointed side-looking to the aircraft's desired track and continuous imaging of the terrain flown by is generated; range Doppler profiling (RDP) mode in which the antenna is pointed at an ocean going vessel and an animated image of the target is produced with time; and, spotlight mode in which the antenna is again trained on a target of interest and a single, high resolution image of the target is produced. Spotlight has two submodes: adaptive spotlight for ship imaging and non-adaptive spotlight for land imaging. The SSAR eXploratory development model (XDM) was completed in 1990 and work since then has been oriented towards improving the system's performance and resolution, enhancing the signal processing routines and developing a real time airborne signal processor. An overview of the SSAR system is given. The original motive for the development of the SSAR was to aid in maritime surveillance. The SSAR system would produce at long range, a high resolution image of ocean going vessels from which the radar operator could discern vessel type. The land imaging capability and enhanced resolution of SSAR however, has created interest in its potential application to other areas such as arms verification and situational awareness.
Author
Synthetic Aperture Radar; Search Radar; Real Time Operation; High Resolution; Image Resolution; Surveillance; Target Acquisition

19970006893 Thomson-CSF, Radars and Contre Measures, Elancourt, France
IMAGING TOOLS FOR SPACEBORNE SAR PROGRAMME
Hermer, J. M., Thomson-CSF, France; Normant, E., Thomson-CSF, France; Martynerie, P., Thomson-CSF, France; Hardange, J. P., Thomson-CSF, France; Boutry, J. M., Office National d'Etudes et de Recherches Aerospatiales, France; Erich, U., Daimler-Benz Aerospace A.G., Germany; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The image chain engineering for a spaceborne synthetic aperture radar (SAR) requires the support of simulation tools and airborne demonstrators. In the future German/French spaceborne SAR program, several of these means are already used. Others are under development or under project. The main simulation tool in France is the SIROS simulator, specified and operated by CELAR in Rennes. In Germany, related tools are being developed by Dornier and DLR, i.e. SAR parameter synthesis and SAR performance analysis. Four airborne demonstrators are actually in operation. The airborne radar demonstrators are used to collect data in order to determine the characteristics of the clutter and of the targets and to identify all the physical phenomena related to the interactions between the electromagnetic wave and the targets in their environments. The future spaceborne radar will have image quality characteristics and detection capabilities which will require the use of advanced techniques such as spotlight imaging, space time adaptive processing, and jammer cancellation. These techniques will be verified through a complete program of qualification and test requiring simulations and in flight demonstration.
Author
Airborne Radar; Computerized Simulation; Physical Factors; Synthetic Aperture Radar; Target Acquisition; Image Resolution; Reliability Analysis; Space Based Radar

19970006894 Centre d'Electronique de l'Armement, Bruz, France
SARAPE: A TOOL FOR RADAR CLUTTER MEASUREMENT *SARAPE: UN OUTIL DE MESURES RADAR DU FOUILLIS*
Motet, Jean-Claude, Centre d'Electronique de l'Armement, France; Marechal, B., Centre d'Electronique de l'Armement, France; Cochin, Christian, CRIL Ingenierie, France; Guillerey, Regis, Alcatel TITN Answare, France; Berges, Andre, Centre d'Etudes et de Recherches, France; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In French; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes the development of simulation tools which include, among other things, a facility for the radar modeling of targets and their environments. These models use data derived from high resolution radar measurement equipment. The equipment, which is fully land mobile, enables the generation of high resolution polarimetric radar images of scenes at variable observation elevations in the 2-18 GHz range. Results from a measurement campaign carried out at the end of 1995 are presented.
Derived from text
Computerized Simulation; Radar Imagery; Radar Measurement; Clutter; Airborne Radar; Target Acquisition

19970006895 Pennsylvania State Univ., Dept. of Remote Sensing, State College, PA United States
REMOTE SENSING BY ACTIVE AND PASSIVE OPTICAL TECHNIQUES
Philbrick, C. R., Pennsylvania State Univ., USA; OBrien, M. D., Pennsylvania State Univ., USA; Lysak, D. B., Pennsylvania State Univ., USA; Stevens, T. D., Pennsylvania State Univ., USA; Balsiger, F., Pennsylvania State Univ., USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Active optical remote sensing techniques based on lidar have been mostly limited to ground based and aircraft applications because of rather restrictive I/R squared dependence of signal, low power efficiency (-1 percent) of flash lamp pumped lasers and large physical size required by the power system. The advances in diode pumped lasers and other electro-optical instruments make it possible to consider new possibilities. Opportunities for future aircraft, remotely piloted vehicles (RV) and satellite platform measurements over large spatial scales have prompted us to evaluate current capabilities for ground-based lidar measurements with a view toward future compact lidars. We have examined the Raman and Dial lidar techniques to determine their capability for various remote sensing applications. The Raman techniques, even with inherent sensitivity disadvantages of small scattering cross sections, have proven to be highly successful for ground-based remote sensing because they easily provide quantitative results, and these techniques will still be valuable from aircraft altitudes. Examples of ground-based lidar measurements of structure properties and minor species profiles have been used to provide confidence in the model calculations of expected performance from flight platforms. The use of acousto-optical tunable filters (AOTF) with lidar techniques provides special capabilities for measurement of Raman and fluorescent lidar returns. Applications of SPR-DIAL techniques for high altitude platforms would be useful for detection of chemical pollution in the atmosphere and waterways. Capabilities of current ground-based lidar systems for profiling meteorological properties, such as: density, temperature, water vapor, refractivity, chemical species, aerosol extinction, and particle characteristics, provide the base from which we may consider future applications. Our recent reports have

described the capability of lidars to measure species and temperature profiles. This paper focuses on the ability of lidar to measure and quantify aerosol properties.
Author
Acousto-Optics; Optical Radar; Differential Absorption Lidar; Electro-Optics; Remote Sensing; Airborne Equipment; Satellite Observation; Tunable Filters

19970006896 Centre des Etudes Terrestraire et Planetaire, Saint Maur des Fosses, France
DIFFUSION OF MICROWAVES BY NON-SPHERICAL AND INHOMOGENEOUS HYDROMETERS: SIMULATIONS, OBSERVATIONS, AND RESTORATIONS DURING THE TOGA-COARE EXPERIMENT ***DIFFUSION DES MICRO-ONDES PAR DES HYDROMETEORES NON SPHERIQUES ET INHOMOGENES: SIMULATIONS, OBSERVATIONS ET RESTITUTIONS DURANT L'EXPERIENCE TOGA-COARE***
Obligis, E., Centre des Etudes Terrestraire et Planetaire, France; Klapisz, C., Centre des Etudes Terrestraire et Planetaire, France; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In French; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The inversion of a radiative transfer model allows one to restore geophysical parameters starting with airborne radio metric data obtained on 6 February during the TOA-COARE experiment. These parameters are liquid precipitation, frozen precipitation, and cloud based vapor. Unfortunately, it is impossible to validate these results. However, the comparison with the precipitation rates obtained from these radar data shows that the major precipitation structures are suitably restored. An improvement of the radiative transfer model consists of introducing a layer of a mixture or a layer of melted ice, in order to take into account the presence of a bright band in stratiform location. The theories of Mie, Tmatrice, and of enclosed spheres are used to obtain vertical profiles of the diffusion and extinction coefficients in this part of the atmosphere. The variations of these coefficients in this zone are more important as the frequency is low and the snow density low. Therefore, it seems necessary to also take into consideration this mixed layer in the radiative transfer model.
Author
Diffusion Coefficient; Hydrometers; Radiative Transfer; Inversions; Radar Data; Airborne Radar; Clouds; Vertical Distribution

19970006897 Naval Command, Control and Ocean Surveillance Center, Propagation Div., San Diego, CA United States
AN OVERVIEW OF EOPACE (ELECTROOPTICAL PROPAGATION ASSESSMENT IN COASTAL ENVIRONMENTS), INCLUDING IN SITU AND REMOTE SENSING TECHNIQUES
Littfin, Kathleen M., Naval Command, Control and Ocean Surveillance Center, USA; Jensen, Douglas R., Naval Command, Control and Ocean Surveillance Center, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Electro-optical Propagation Assessment in Coastal Environments (EOPACE) is a five year multi-national effort to characterize electro-optical (EO) propagation in coastal environments. Existing EO performance codes incorporate models that were developed for open ocean conditions. These codes are not applicable to coastal environments where small surface craft and sea skimming missiles pose threats. Coastal environments may differ significantly from open ocean conditions, and need to be fully characterized. The objectives of EOPACE are threefold: (1) to investigate coastal aerosols by studying surf production, coastal air mass characteristics, and near ocean surface transmission characteristics; (2) to develop mesoscale and data assimilation models; and (3) to evaluate EO systems performance by studying targets and backgrounds, polarization techniques, performance of forward looking infrared (FLIR) and infrared search and track (IRST) systems, and tactical decision aids. During EOPACE, in situ and remote sensing techniques will be used to infer the impact of surf generated aerosol, air mass parameterization required for propagation codes, near ocean surface infrared transmission properties, and IRST/FLIR systems performance in coastal environments. This paper gives an overview of the EOPACE effort and discusses the in situ and remote sensing techniques used.
Author
Aerosols; Marine Meteorology; Coastal Water; Coasts; Atmospheric Models; Electro-Optics; Remote Sensing; In Situ Measurement

19970006898 Johns Hopkins Univ., Applied Physics Lab., Laurel, MD United States
LATERAL RESOLUTION CONSIDERATIONS OF REFRACTIVITY PROFILES ASSOCIATED WITH REMOTE SENSING MEASUREMENTS OF OVER-WATER COASTAL REGIONS
Goldhirsh, Julius, Johns Hopkins Univ., USA; Dockery, G. Daniel, Johns Hopkins Univ., USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 14p; In English; See also 19970006887; Original contains color illustrations
Contract(s)/Grant(s): N00039-95-C-0002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A means to assess propagation conditions is to obtain sets of vertical refractivity profiles employing remote or in situ sensing methods, and to inject these profiles into propagation models from which we calculate propagation factor fields. Fundamental questions which are addressed in this effort are: (1) What errors are introduced when only a single measurement of refractivity profile is possible and the refractivity environment is assumed laterally homogeneous? (2) Where multiple profiles are capable of being measured, what errors are introduced for different profile spacings? Errors in the propagation factor field at 1 GHz, 3 GHz, and 10 GHz over broad areas of the lower troposphere are quantified in this paper as they relate to the above questions for two coastal regions; namely, the coastal regions of Wallops Island, Virginia, and San Nicolas Island, California.
Author
Coasts; Refractivity; Troposphere; Error Analysis

19970006900 Rutherford Appleton Lab., Oxford, United Kingdom
MODELLING OF ROUGH SURFACE EFFECTS WITH THE MATCHED TRANSFORM PE
Levy, M. F., Rutherford Appleton Lab., UK; Remote Sensing: A Valuable Source of Information; Oct. 1996; 6p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Generalized impedance boundary conditions allow the rigorous modeling of propagation over surfaces with angle-dependent reflection coefficients. We present a split-step parabolic equation (PE) implementation based on a matched transform approach. The method is applied to propagation over the rough sea in ducting conditions and to ground-wave calculations.
Author
Boundary Conditions; Parabolic Differential Equations; Sea Roughness; Impedance; Wave Propagation

19970006903 Danish Defence Research Board, Copenhagen, Denmark
ON THE IMPORTANCE OF UTILIZING POLARIMETRIC INFORMATION IN RADAR IMAGING AND CLASSIFICATION
Krogager, E., Danish Defence Research Board, Denmark; Boerner, W. -M., Illinois Univ., USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 14p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Some basic polarization phenomenology and terminology, including the radar target scattering matrix, will be introduced. Significant advances of polarimetric radar over single polarization radar are pointed out by considering the response, i.e., the scattering matrix, for a set of significantly different elementary scatterers. The handling of polarimetric radar data requires special techniques. Examples of such techniques are explained, in particular the decomposition into physically relevant target constituents, and examples of actual applications to measured polarimetric synthetic aperture radar (SAR) data are demonstrated.
Author
Polarimetry; Synthetic Aperture Radar; Radar Data; Radar Targets; Imaging Techniques; Target Acquisition

19970006904 Centre National d'Etudes Spatiales, Meteo France, Toulouse, France
PROBLEM OF MODELING RELATED TO TIME LIMITATION OF THE PULSE EMITTED BY THE POSEIDON RADAR-ALTIMETER
PROBLEME DE MODELISATION LIE A LA LIMITATION TEMPORELLE DE L'IMPULSION EMISE PAR LE RADAR-ALTIMETRE POSEIDON
Barckicke, Jean, Centre National d'Etudes Spatiales, France; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In French; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes the problems of modeling related to time limitations of the pulse emitted by a satellite-borne radar altimeter. A precise examination of the classical echo model and the properties of the altimeter signal allow one to show that the hypotheses required for traditional resolution are not verified. The specific results of the signal processing are then examined in order to explain the noise features of real echoes.
Derived from text
Satellite-Borne Radar; Satellite Altimetry; Radio Altimeters; Signal Processing; Radar Echoes

19970006905 Naples Univ., Dipartimento di Scienza ed Ingegneria dello Spazio 'L.G. Napolitano', Italy
CHARACTERIZATION OF NATURAL TARGETS USING MULTIPARAMETRIC SIR-C/X-SAR IMAGERY
Castellano, L., Naples Univ., Italy; Murino, P., Naples Univ., Italy; Siciliano, A., Naples Univ., Italy; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Original contains color illustrations
Contract(s)/Grant(s): ASI-RS94; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper deals with the characterization of natural targets in terms of backscattering properties using multifrequency multipolarization synthetic aperture radar (SAR) data acquired over the Campanian ares (southern Italy) during the SIR-C/X-SAR shuttle mission of April 1994. The knowledge of the complete scattering matrix, usually measured in a linear basis (HV) allows the computation of a covariance matrix once a polarimetric characteristic vector has been defined. The scattering properties of natural targets, imaged by airborne and spaceborne SAR polarimeters, can be statistically described by such a matrix whose decomposition provides useful information about the nature of scattering mechanisms acting inside the resolution cell. If the polarimetric characteristic vector is defined using a set of simple matrices having a physical significance and if not correlation exists between the co-polarized and the cross-polarized channels, the covariance matrix assumes a very simple form and its decomposition provides a simple tool to get insight into the target scattering behavior.
Author
Radar Data; Radar Imagery; S Matrix Theory; Shuttle Imaging Radar; Synthetic Aperture Radar; Covariance; Resolution Cell; Remote Sensing

19970006906 Centre National d'Etudes Spatiales, CESBIO, Toulouse, France
MICROWAVE REMOTE SENSING OF NATURAL TARGETS: THEORY AND EXPERIMENT
Souyris, Jean-Claude, Centre National d'Etudes Spatiales, France; LeToan, Thuy, Centre National d'Etudes Spatiales, France; Floury, Nicolas, Centre National d'Etudes Spatiales, France; Hsu, Chih-Chien, Massachusetts Inst. of Tech., USA; Wang, Li-Fang, Massachusetts Inst. of Tech., USA; Kong, Jin Au, Massachusetts Inst. of Tech., USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 12p; In English; See also 19970006887
Contract(s)/Grant(s): DRET-94-091; NASw-958461; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The overall objective of this work is the study of radar backscattering from forest canopies and soil surfaces in order to access the use of multifrequency, multi-incidence, and multi-polarization radar data for understanding natural media.
Author
Backscattering; Canopies (Vegetation); Forests; Microwave Imagery; Radar Scattering; Surface Diffusion; Radar Data; Synthetic Aperture Radar

19970006907 Vrije Univ., Dept. of Electronics, Brussels, Belgium
AUTOADAPTIVE SCENE IDENTIFICATION IN MULTI-SPECTRAL SATELLITE DATA
Boekaerts, P., Vrije Univ., Belgium; Nyssen, E., Vrije Univ., Belgium; Cornelis, J., Vrije Univ., Belgium; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A non-supervised scene identification scheme for multi-spectral satellite data is presented. The identification of a scene is equivalent to the assignment of meaningful labels to image regions belonging to the scene. Multi-spectral scene region detection is reduced to the problem of finding an algorithm that performs a data reduction on composite images while (optimally) preserving scene region information. A self-organizing one-dimensional feature map applied to random segments of individual METEOSAT channels has already been shown to meet the requirements of such an algorithm for mono-spectral cloud identification. The use of two- and three-dimensional feature maps cannot be generalized for bi- and tri-spectral scene analysis, but it is shown that conventional clustering algorithms can be used for that purpose. The latter is illustrated for tri-spectral scene analysis in METEOSAT composite images of the visible, infrared, and water vapor channels. A study of the segment size indicates that the small segment sizes are sufficient and even better than large segment sizes for multi-spectral scene detection. This is explained in terms of the distribution properties of the so called segment space and the structural features of the code vectors (code segments). Decreasing the number of code segments used to reduce the information content of METEOSAT composite images results in a systematic loss of scene information. The proposed method for multi-spectral scene identification can be applied to data sets obtained after the fusion of spectral information of different sensors with different resolution and opens interesting perspectives for automated object tracking in temporal sequences of satellite data.
Author
Algorithms; Remote Sensing; Spectrum Analysis; Automatic Control; Cluster Analysis; Image Processing; Multispectral Radar; Multidisciplinary Research; Scene Analysis

19970006908 Boston Univ., Dept. of Aerospace and Mechanical Engineering, Boston, MA United States
MODELING AND WAVE-ORIENTED PROCESSING OF SCATTERING DATA FROM COMPLEX ENVIRONMENTS: LOCATION AND IDENTIFICATION OF BURIED OBJECTS BY GROUND PENETRATING RADAR
Felsen, Leopold B., Boston Univ., USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Inverse algorithms for processing data due to wave scattering from complex environments can be strengthened by incorporating relevant robust wave physics in the inversion scene. Discriminants (footprints) for object classification and identification are best documented in the configuration (space-time) spectrum (wave number-frequency) phase space. Illustrations here emphasize ground penetrating radar (GPR) applications. Because of the complexity of this target-background environment, the processing strategy generally relies heavily on numerical model based and statistical techniques. A model is proposed here which utilizes wave based analytic techniques to reduce the 'size' of the overall problem. The model is structured around high resolution pulsed-beam propagators for transporting the incident signal to and from the target through lossy dispersive soil environments. Attention is given to those portions of an overall problem which are good candidates for wave based analytic methods and those portions which are better served by other methods.
Author
Algorithms; Ground Penetrating Radar; Inversions; Statistical Analysis; Wave Scattering; High Resolution

19970006911 Ecole Royale Militaire, Brussels, Belgium
A GRADIENT BASED LINE DETECTOR
Lacroix, V., Ecole Royale Militaire, Belgium; Acheroy, M., Ecole Royale Militaire, Belgium; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes a gradient-based line detector (GLD) , a line detector filter. The operator makes use of the dot product of neigh-

boring gradient vectors. One pixel wide lines may be obtained after a line following algorithm started on local maxima of the GLD and continuing in the direction of the next maxima. The method presents several interesting aspects: it produces a clean output, it can cope with noise in the intensity, it detects lines of various widths, it may generate an output dependent on the line contrast, and finally, it provides an approximation of the local line width. Applying such a scheme for detecting roads on satellite images provides very good results.
Derived from text
Satellite Imagery; Spectral Line Width; Noise Intensity; Algorithms; Gradients; Edge Detection; Image Processing

19970006916 Naval Command, Control and Ocean Surveillance Center, Propagation Div., San Diego, CA United States
A GLOBAL POSITIONING SYSTEM (GPS) TIDE GAUGE
Anderson, Kenneth D., Naval Command, Control and Ocean Surveillance Center, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 6p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A non-radiating, non-intrusive remote sensing method to measure changes in water height is examined. This tide gauge can be easily set up and be operating in a short amount of time. The amount of time is controlled by the time it takes to set up an antenna and acquire global positioning system (GPS) satellite signals. The equipment package can be small, about the size of two briefcases, and consists of a handheld GPS receiver, a small patch antenna, and a notebook computer. There is no requirement to install equipment in the water to measure the changes in water height. Even though modern tide gauges use non-intrusive height sensors, such as ultrasonic acoustic transducers that send a pulse toward the surface and measure the time delay between the transmission and reception of the pulse, accurate measurements always require the use of a stilling well and that must intrude into the water surface. While not amenable for all locations, the size, ease of installation and remote sensing aspects significantly reduce the logistics cost of a tide gauge. The US National Geodetic Survey (NGS) is interested in evaluating this tide gauge. Possible use is contemplated as a storm surge sensor during hurricanes and as a replacement for gauges installed in difficult areas. In addition, it is likely that the US Navy could use the means during amphibious operations, particularly in areas where the tidal effects are not well known.
Author
Geodetic Surveys; Global Positioning System; Nonintrusive Measurement; Remote Sensing; Tides; Geoids

19970006920 Science and Technology Corp., Hampton, VA United States
AN ALGORITHM FOR SHIP TEMPERATURE RETRIEVAL FROM AIRBORNE INFRARED RADIOMETRIC MEASUREMENTS
Hughes, H. G., Science and Technology Corp., USA; Zeisse, C. R., Naval Command, Control and Ocean Surveillance Center, USA; McGrath, C. P., Naval Command, Control and Ocean Surveillance Center, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887
Contract(s)/Grant(s): N66001-94-0064; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A remote sensing technique is described which enables the zero-range average temperature of a ship to be determined. The temperature is determined from airborne infrared radiometric measurements and vertical profiles of meteorological parameters with a modified version of the LOWTRAN7 computer code to remove the effects of the atmosphere and the sensor responsivity. Using long wave (LW) infrared ship signatures obtained with an airborne thermal imager (AGEMA 900) at different ranges, the algorithms ability to remove the effects of the atmosphere is examined. The sensitivity of the inferred zero-range temperatures to uncertainties in the ship's surface emissivity and the resulting effects on system performance predictions are discussed.
Author
Airborne Equipment; Algorithms; Atmospheric Effects; Emissivity; Infrared Radiation; Infrared Signatures; Radiometers; Remote Sensing

19970006921 Centre d'Etudes et de Recherches, Toulouse, France
SOME RESULTS FROM AGARD STUDY AAS-42: POTENTIAL USE OF COMMERCIAL SATELLITE SYSTEMS FOR MILITARY APPLICATIONS
Dinguirard, Magdeleine, Centre d'Etudes et de Recherches, France; Wahl, Terje, Norwegian Defence Research Establishment, Norway; McDonald, James Murray, Office of Naval Research, USA; Carrin, Gerard, MATRA Marconi Space, France; Levy, David, Centre National d'Etudes Spatiales, France; Erich, Ull, Dornier Luftfahrt G.m.b.H., Germany; Zeller, Karl Heins, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Briottet, Xavier, Centre d'Etudes et de Recherches, France; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The commercialization of space is rapidly making satellite communications, navigation, and remote sensing accessible to many users, both civilian and military. In 1994 it was decided that there was a need for an AGARD study of consequences to NATO of this new trend. A study covering satellite communications, satellite navigation, and satellite remote sensing, focused on both the possible NATO use and the threats of adversarial use of communications satellites against NATO was carried out. As part of this study, data on most known or planned non-military remote sensing satellites have been collected and analyzed, and some of the results of this analysis are reported here. Among the new elements that have been considered are commercial satellites with a resolution better than 10 meters, and near real time processing and delivery of synthetic aperture radar (SAR) images from radar satellites. It is clear that well-organized use of non-military remote sensing satellites among NATO countries can be a valuable supplement to current NATO surveillance data sources. Also, in certain kinds of crises or conflicts, fast access to commercial remote sensing images can have a high value for a potential NATO adversary.
Author
Military Technology; Radar Imagery; Real Time Operation; Satellite Observation; Remote Sensing; Synthetic Aperture Radar; Military Operations; Image Processing

19970006922 Canadian Space Agency, Canadian Forces Detachment., Saint Hubert, Quebec Canada
RADARSAT: A DUAL USE EARTH OBSERVATION SYSTEM
McKean, M., Canadian Space Agency, Canada; Edel, H., Department of Fisheries and Environment, Canada; Dionne, J. L. P., Canadian Space Agency, Canada; Rey, M., Defence Research Establishment Ottawa, Canada; Bjerkelund, C., Canada Centre for Remote Sensing, Canada; Nazarenko, D., Radarsat International, Inc., Canada; Remote Sensing: A Valuable Source of Information; Oct. 1996; 14p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper provides an overview of the resource management and surveillance requirements which led to the initial approval of the RADARSAT project, reviews the key elements of the operational system, and describes some of the capabilities that could assist the UN and NATO in promoting international peace and security. Recent research and ongoing trials aimed at demonstrating the ability of the RADARSAT system to satisfy the operational requirements associated with some of these peace and security applications are also addressed.
Author
Earth Observations (From Space); Radarsat; Remote Sensing; International Cooperation; Military Operations; Cost Effectiveness

19970006924 Interarmy Geographic Center, Arcueil, France
DEFENSE DIGITAL SPACE MAP *LA SPATIOCARTE NUMERIQUE DEFENSE*
Sclafer, M. N., Interarmy Geographic Center, France; Cantou, J. P., Institut Geographique National Espace, France; Remote Sensing: A Valuable Source of Information; Oct. 1996; 4p; In French; See also 19970006887; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

This paper describes a space map created in the civilian area because of the need for an available means of cartography that is up to date and inexpensive. This is comprised of a background image which is corrected within the geometry of traditional maps and enhanced by cartographic corrects. The space map was first modified in analog form and thus constituted one of the main promotion vectors

of the imagery acquired by the SPOT satellite. Their ground resolution, which heretofor is unequal (10 m) is perfectly suited to produce, in just a few weeks, coverage on the scales of 1:50,000 and 1:100,000 for .arge territories that have not been well mapped.
Derived from text
Spot (French Satellite); Digital Techniques; Satellite Imagery; Mapping; Maps

19970006926 Forschungsinstitut fuer Hochfrequenzphysik, Werthhoven, Germany
SAR MEASUREMENTS OF EXTENDED TARGETS AT 94 GHZ
Schimpf, H., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Essen, H., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In recent years, radar imaging has gained more and more importance for military applications. In a side-looking synthetic aperture radar (SAR) configuration, the combination of Doppler processing and high range resolution via frequency agility provides a comparable resolution in cross range and range. In the first part of this paper, some fundamental issues like depth of focus, range migration, and speckle statistics are addressed and compared to results at the more commonly used longer wavelengths. The second part of the paper discusses several ways to use the polarimetric information within each pixel for the detection and discrimination of extended targets. A comparison is made between a polarimetric whitening filter, a selective Stokes vector averaging, and other methods that may help obtain a stable description of the polarimetric state of the signals to be processed subsequently. The main effort is aimed at discriminating extended man-made objects from a natural clutter background.
Derived from text
Synthetic Aperture Radar; Airborne Radar; Frequency Hopping; Imaging Techniques; Polarimetry; Target Acquisition

19970006930 Istanbul Univ., Dept. of Remote Sensing, Turkey
USE OF REMOTE SENSING FOR MONITORING THE LAGOON KOEYCEGIZ AND ITS ENVIRONMENT IN TURKEY
Maktav, D., Istanbul Univ., Turkey; Sunar, F., Istanbul Univ., Turkey; Kapdash, S., Istanbul Univ., Turkey; Musaoglu, N., Istanbul Univ., Turkey; Remote Sensing: A Valuable Source of Information; Oct. 1996; 6p; In English; See also 19970006887; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Koeycegiz Lagoon in Turkey is part of an area declared a specially protected area. The goal of this study was to monitor this lagoon by integrating conventional water quality data and satellite remote sensing data.
Author
Remote Sensing; Satellite Imagery; Lagoons; Water Quality; Thematic Mappers (LANDSAT)

19970006931 Naval Air Warfare Center, Geophysics Branch, Point Mugo, CA United States
SYNOPTIC VARIABILITY REVEALED BY SATELLITE AND EQUIVALENT ALTITUDE
Greiman, Paul, Naval Air Warfare Center, USA; Rosenthal, Jay, Naval Air Warfare Center, USA; Helvey, Roger, Naval Air Warfare Center, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 12p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Both real time assessments of electromagnetic (EM) propagation conditions (in the absence of direct measurements) and inferential techniques of forecasting duct occurrence, height, and intensity require the a priori knowledge of the relation between these duct parameters and the standard weather variables which describe large and mesoscale air mass features. Through pattern recognition of stratus/stratocumulus cloud features on meteorological satellite imagery, and by identification of air mass sectors and wind circulation, it is possible to estimate the present and future state of the radar propagation environment by first determining the spatial and temporal variability of inverse conditions, weather map features, and cloud features on weather satellite imagery.
Author
Air Masses; Atmospheric Circulation; Electromagnetic Wave Transmission; Meteorological Satellites; Satellite Imagery; Pattern Recognition; Stratocumulus Clouds

19970006932 Naval Command, Control and Ocean Surveillance Center, Propagation Div., San Diego, CA United States
REMOTE SENSING OF EVAPORATION DUCTS USING SHF PROPAGATION MEASUREMENTS
Rogers, L. Ted, Naval Command, Control and Ocean Surveillance Center, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 10p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A maximum likelihood method is implemented to determine the height of the evaporation duct from multifrequency, slightly beyond line-of-sight super high frequency (SHF) propagation measurements using data from the NATO sponsored propagation experiment in the vicinity of Lorient, France, during the fall of 1989. The model for the propagation environment is horizontally homogeneous with a vertical structure having two parameters, the evaporation duct height and the trapping layer base height. The environmental parameter space is discretized and propagation factors are computed using a parabolic equation model for each point in the parameter space. The relative likelihood of combinations of the environment parameters are computed from the mismatch of the vectors of modeled and measured propagation factors. Good agreement is found with evaporation duct heights calculated using bulk meteorological models.
Author
Superhigh Frequencies; Vertical Distribution; Evaporation; Remote Sensing; Ambient Temperature; Refractivity; Electromagnetic Wave Transmission

19970006934 Harvard-Smithsonian Center for Astrophysics, Cambridge, MA United States
EXPECTATIONS FROM EMET AND OESEE GROUND LISTENING OF POSSIBLE E.M. EVENTS GENERATED BY THE TSS 1R
Estes, Robert D., Harvard-Smithsonian Center for Astrophysics, USA; Sanmartin, Juan, Universidad Politecnica de Madrid, Spain; Tacconi, Giorgio, Genoa Univ., Italy; Remote Sensing: A Valuable Source of Information; Oct. 1996; 12p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Tethered Satellite System 1 Reflight (TSS 1R) program is a bilateral scientific agreement between NASA and the Italian Space Agency (ASI). The TSS 1R system consists of the shuttle Columbia which deploys, upward, by means of a 20 km long tether, a spherical satellite (1.5 m in diameter) containing scientific instrumentation. This system, orbiting at about 300 km from the Earth's surface, represents, presently, the largest experimental space structure. Due to its dimensions, flexibility, and conducting properties of the tether, the system interacts in a quite complex manner with the Earth's magnetic field and the ionospheric plasma, in such a way that the total system behaves as an electromagnetic radiating antenna as well as an electric power generator.
Derived from text
Tethered Satellites; Tethering; Electromagnetic Wave Transmission; Ionospheric Propagation; Magnetic Fields

19970012592 Battelle Columbus Labs., OH United States
SCENE/OBJECT CLASSIFICATION AND SEGMENTATION USING MULTISPECTRAL DATA FUSION
Lazofson, L. E., Battelle Columbus Labs., USA; Kuzma, T. J., Battelle Columbus Labs., USA; Choe, H. C., Battelle Columbus Labs., USA; Preston, E. B., Battelle Columbus Labs., USA; Chovan, J. D., Battelle Columbus Labs., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 175-184; In English; See also 19970012579; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Near-simultaneous, multispectral imagery of ground target and background signatures were collected over a full diurnal cycle in visible, infrared, and ultraviolet spectrally filtered wavebands using Battelle's portable sensor suite. The imagery data were coregistered and processed using a variety of classical statistical algorithms, artificial neural networks and data clustering techniques to classify pixels and objects in the imaged scenes. Imagery collected at different times throughout the day were employed to verify algorithm robustness with respect to temporal variations of spectral signatures. Sensor fusion hardware was also designed and built to accompany the sensor suite to provide real-time pixel classification capability. In addition, research is being performed to advance the state of the art using differential absorption lidar as an active remote sensing technique for spectrally detecting, identifying, and tracking hazardous emissions. These

investigations support a wide variety of multispectral signature discrimination applications, including automated target search and landing zone detection. Battelle's sensor suite has also been used to quantify the extent of natural gas leaks and record the thermal characteristics of smoke grenades.
Derived from text
Imaging Techniques; Data Acquisition; Target Acquisition; Target Recognition; Multisensor Fusion

19970026421 Norwegian Defence Research Establishment, Kjeller, Norway
NATO NAVAL EXERCISES AS OBSERVED FROM CIVILIAN RADAR SATELLITES
Wahl, Terje, Norwegian Defence Research Establishment, Norway; Skoelv, Age, Norwegian Defence Research Establishment, Norway; Jun. 1997; 4p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Near real time use of the radar satellite ERS-1 has been demonstrated during several NATO naval exercises in Norwegian waters. In several cases low resolution SAR images have been satisfactory for detection of ships, while full resolution images have provided some additional information about the ships. Oceanographic features of interest for operation of acoustic sensors have also been observed. The steep incidence angle of ERS-1 is a very limiting factor for detection of smaller ships. The upcoming satellites RADARSAT and ENVISAT will improve on this.
Derived from text
Synthetic Aperture Radar; Signal Detectors; Real Time Operation; Oceanography; Radar Imagery

19970026426 Alenia Spazio S.p.A., Rome, Italy
TACTICAL RECONNAISSANCE BY A CONSTELLATION OF SMALL SATELLITES
Dionisio, C., Alenia Spazio S.p.A., Italy; Perrotta, G., Alenia Spazio S.p.A., Italy; Jun. 1997; 8p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The need for tactical reconnaissance satellites has been well assessed in the recent few years. Many concepts have been explored and proposed, mainly based on small satellites. The present technology permits the implementation of good performance instruments suitable to withstand with the limited resources of the small satellites. Alenia Spazio has been studied the architecture of constellation of small satellites both for civil and military applications since four years and the scope of this paper is to present the status of the projects. Despite the proposed satellite configuration is tailored on military requirement, the dual use of technology and resources is of paramount importance in a world where investments must be returned and optimized. This aspect with its implications shall be discussed in relation to the system architecture.
Author
Satellite Configurations; Military Technology; Reconnaissance; Satellite Design; Spacecraft Defense; Satellite Constellations

19970026430 Office of Naval Research, Space Technology and Liaison Office, Arlington, VA United States
INTEGRATED AIR DEPLOYED STRIKE SURVEILLANCE (IADSS)
OConnell, Patrick, Office of Naval Research, USA; Bielecki, Daria J., Office of Naval Research, USA; Jun. 1997; 8p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The U.S. Navy's Integrated Air Deployed Strike Surveillance (IADSS) initiative is a pathfinder effort in defining the next generation sensor and mission management systems for unmanned air vehicles (UAV). The sensor suite in development will be capable of deterministic to fully autonomous operations. This includes the capabilities for dissimilar sensor queuing, automatic sensor search and automatic target recognition. A key developmental item is the autonomous management system (AMS) that will "manage" the expanded onboard sensor suite. The envisioned equipment suite includes signal detection equipment, imagery systems and a duplex communication system. This paper is presented in three parts: an overview, the operational demonstrations and the supporting Science and Technology.
Derived from text
Aerial Reconnaissance; Management Systems; Deployment; Target Recognition; Signal Detection

19980210653 Physics and Electronics Lab. TNO, The Hague, Netherlands
MULTI-SENSOR REMOTE SENSING FOR MILITARY CARTOGRAPHY
vandenBroek, A. C., Physics and Electronics Lab. TNO, Netherlands; Hoogeboom, P., Physics and Electronics Lab. TNO, Netherlands; vanPersie, M., National Aerospace Lab., Netherlands; Apr. 1998; 8p; In English; See also 19980210650
Contract(s)/Grant(s): A95/KL/756; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

We have studied remote sensing data from sensors in different wavelength regions (optical, thermal infrared and microwave) and from different platforms (airborne and spaceborne) in order to extract geographical information. By comparing the extracted information with an existing geographical database of a test area in the Netherlands we find that to obtain military relevant cartographic information from remote sensing images resolutions of 5 meter or less are required. For appropriate classification of extended objects like agricultural fields multi-layer imagery is necessary.
Author
Multisensor Applications; Infrared Radiation; Remote Sensing; Microwaves

19980210654 Thomson-CSF, Image and Geographic Information Unit, Malakoff, France
DESIGN OF MULTI-SENSOR SYSTEM FOR 3D SITE MODEL ACQUISITION AND EXPLOITATION
Tannous, I., Thomson-CSF, France; Gobert, S., Thomson-CSF, France; Laurencot, T., Thomson-CSF, France; Dulac, J.-M., Thomson Training and Simulation Ltd., France; Goretta, O., Ministry of Defence, France; Apr. 1998; 10p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The increasing number of high resolution image sensors in a near future, as well as the need for realistic 3D site databases for applications like simulation, terrestrial mission preparation and training, has emphasized the need for multi-sensor image-based system dedicated to the production and exploitation of 3D site model. We present here the design of such a system, including the required functionalities for this purpose. The system comprises a geometric reconstruction step, which aims at producing a geometrically reliable 3D model of the site, including the topography, from the aerial or satellite images available. Next step is the exploitation of other images, especially terrestrial photographs, for the mapping of real textures on the faces of the reconstructed objects, as well as the texturation of the terrain. The output of this stage is a realistic 3D site model that can be used by the exploitation module of the system, allowing the real time reconstruction of the scene from any point of view, interactively or according to a predefined scenario. This system has been prototyped by SYSECA and THOMSON TRAINING & SIMULATION (both subsidiaries of THOMSON-CSF) using their own software, and the results of an experimentation with real data have demonstrated the feasibility of our approach.
Author
Multisensor Applications; Three Dimensional Models; Topography; Image Analysis; Satellite Imagery

19980210655 Forschungsinstitut fuer Hochfrequenzphysik, Werthoven, Germany
AIRBORNE DUAL SENSOR MILLIMETER WAVE-SIGNATURES OF MARITIME TARGETS AND SEA-CLUTTER
Makaruschka, R., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Essen, H., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Apr. 1998; 7p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In the framework of a NATO measurement campaign airborne signature measurements were conducted over sea with the dual frequency, polarimetric mm W Synthetic Aperture Radar MEMPHIS (Millimeterwave Experimental Multifrequency Polarimetric High Resolution Imaging System) with simultaneous operating front-ends at 35 GHz and 94 GHz onboard a cargo aircraft in side-looking configuration. Both front-ends are tied to the same system reference and are using the same IF pre-processing and radar waveform-generator. So as well a concise comparison between data at relevant mm W bands simultaneously. the two frequency bands, 35 GHz and 94 GHz, can be made The performance data of the front-ends are summarized in as a use of the data for multichannel/multifrequency SAR processing.

The paper describes the system configuration and the mm W-SAR processing algorithm and gives representative results for the generated radar images for ship targets, chaff and the sea clutter with emphasis on the multiparameter evaluation.
Author
Airborne Equipment; Aircraft Configurations; Radar Imagery; Synthetic Aperture Radar; Millimeter Waves; Imaging Techniques

19980210659 Universitaet der Bundeswehr, Allgemeine Nachrichtentechnik, Hamburg, Germany
IR-SIGNATURES OF SHIPS: A CLASSIFICATION FEATURE WITHIN A SENSOR NETWORK
vomStein, H. D., Universitaet der Bundeswehr, Germany; Guenther, J., Universitaet der Bundeswehr, Germany; Haese, K., Universitaet der Bundeswehr, Germany; Apr. 1998; 10p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A system is described by which on the basis of IR-signatures ships are classified using methods of varying interactivity. A sequence of images taken with an IR-camera in a sea environment is superimposed so that pixels in corresponding frames match as closely as possible. With this motion compensation and a following long-term filtering the signal-to-noise ration is significantly improved. Subsequently the contour lines of the ship are extracted by a good signal-to-noise ratio this can be done automatically in other cases an interactive component is necessary. The contour of the 'unknown' ship is the feature for a correlative or a neuronal classifier. For both classifiers the reliability and the computing time is strongly dependent upon the size of the reference database. It is of inestimable benefit to include all the available sensor data (e.g. sonar and radar) in the classification process thus quickly and significantly reducing the initially very large search space.
Author
Signal to Noise Ratios; Infrared Signatures; Infrared Photography

19980210662 Centre d'Etudes et de Recherches, Toulouse, France
RECOGNITION OF DYNAMIC SCENES ON THE BASIS OF DATA COMING FROM DETECTORS: THE PERCEPTION PROJECT *RECONNAISSANCE DE SCENES DYNAMIQUES A PARTIR DE DONNEES ISSUES DE CAPTEURS: LE PROJET PERCEPTION*
Tessier, Catherine, Centre d'Etudes et de Recherches, France; Apr. 1998; 9p; In French; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The objective of the Perception Project is to study and develop methods that make it possible - on the basis of the observation of the environment by different detectors - to prepare and update a representation of the real world, suitable for facilitating the adoption of a decision. The project thus contributes to meeting, in a general fashion, the operational needs of monitoring, surveillance, information (intelligence), reconnaissance, be it in the setting of autonomous systems or systems for aiding in decision-making, whose overall function is within the context of a closed perception - decision - action loop.
Author
Pattern Recognition; Perception; Reconnaissance; Surveillance

19980210687 Wright Lab., Wright-Patterson AFB, OH United States
NONLINEAR OPTICAL FREQUENCY CONVERSION MATERIALS FOR MULTI-BAND REMOTE SENSING AND SURVEILLANCE
Caracci, S., Wright Lab., USA; Fernelius, N., Wright Lab., USA; Ohmer, M., Wright Lab., USA; Zelmon, D., Wright Lab., USA; Apr. 1998; 9p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

There exists many nonlinear frequency conversion materials today which provide access to wavelength bands not previously possible by other means (solid state, gas, or semiconductor lasers). of particular interest are optical sources for the 3-5 (micron) and the 8-12 (micron) wavelength bands. Operation in these optical transmission bands is very advantageous due to the large optical absorption of important chemical and biological materials and the low absorption of the atmosphere. A brief introduction of the uses of optical remote sensing and the unique properties of nonlinear materials for laser frequency conversion are described.
Author
Frequency Converters; Nonlinearity; Light Transmission; Semiconductor Lasers; Surveillance

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ENVIRONMENT POLLUTION

19950025756 Esquimalt Defence Research Detachment, Victoria British Columbia, Canada
TREATMENT OF PLASTIC MEDIA WASTE
Foster, Terry, Esquimalt Defence Research Detachment, Canada; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 1 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

Although plastic media itself is not generally considered a hazardous waste, the paint particles containing chromate pigments contaminating the spent media are considered a hazardous waste product. There are currently four approaches under investigation aiming to reduce the volume of hazardous waste produced during paint stripping: elimination of the chromate containing pigments or other hazardous pigments from primers and coatings; separation of the paint or hazardous materials from the plastic or other media; encapsulation or recycling of the contaminated media to make it safe for disposal or reuse; and produce a biodegradable media. Research to develop new pigments and primers that will result in the elimination of hazardous pigments such as strontium chromate and in developing alternative anti-corrosive surface treatments to replace cadmium plating is continuing. Contamination of the spent media will remain a problem because the hazardous pigments and surface treatments will still be used on aircraft and their components for the foreseeable future. Therefore, the only realistic alternatives at the moment to reduce the volume of hazardous waste produced by PMB (plastic media blasting) are to recycle or re-use the media in some form or remove the hazardous materials from the media.
Derived from text
Alternatives; Chromates; Contamination; Paints; Pigments; Plastics; Toxic Hazards; Waste Treatment

19950025757 Aerospatiale, Direction des Etudes., Toulouse, France
BIOREMEDIATION OF WHEAT STARCH MEDIA WASTE
Malavallon, Olivier, Aerospatiale, France; Oestreich, John, CAE Electronics Ltd., Canada; AGARD, Environmentally Safe and Effective Processes for Paint Removal; Apr 1, 1995, 2 p; In English; See also 19950025744; Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

The development of a bioremediation process is designed to minimize most of the waste generated with dry media paint removal. The bioremediation method was developed by DOT Technologies in Canada. When paint is removed with wheat starch media, a dust waste is produced containing both starch and paint. The waste will also contain a percentage of inorganic materials from the starch, the paint waste and contaminants from the aircraft (sealants, tapes, ...). This disposal method first uses enzymes to render the starch component soluble in water, converting the starch to various sugars. Specially bred bacteria then digest the sugars, and some of the hydrocarbons in the paint. At this stage, the primary end products are carbon dioxide and water. This bioremediation method reduces the waste generated by dry paint removal by approximately 95 percent. The bacteria, bred by natural selection, tolerates high levels of heavy metals, and toxic hydrocarbons. The basic chemistry of bioremediation, as well as the management of bacteria in this application are summarized hereafter.
Derived from text
Contaminants; Enzymes; Paints; Starches; Stripping; Toxicity; Waste Treatment; Wheat

19960008938 Thiokol Corp., Brigham City, UT, United States
ENVIRONMENTAL IMPACTS FROM LAUNCHING CHEMICAL ROCKETS
Mcdonald, Allan J., Thiokol Corp., USA; Bennett, Robert R., Thiokol Corp., USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 14 p; In English; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Three independent studies have been conducted for assessing the impact of rocket launches on the earth's environment. These studies have addressed issues of acid rain in the troposphere, ozone depletion in the stratosphere toxicity of chemical rocket exhaust products and the potential impact on global warming from carbon dioxide emissions from rocket launches. Local, regional, and global impact assessments were examined and compared with both natural sources

and anthropogenic sources of known atmospheric pollutants with the following conclusions: (1) Neither solid nor liquid rocket launches have a significant impact on the earth's global environment and there is no real significant difference between the two; (2) Regional and local atmospheric are more significant than global impacts, but quickly return to normal background conditions within a few hours after launch; and (3) Vastly increased space launch activities equivalent to 50 U.S. Space Shuttles or 50 Russian Energia launches per year would not significantly impact these conclusions.
Derived from text
Chemical Propulsion; Damage Assessment; Environment Effects; Exhaust Emission; Liquid Rocket Propellants; Rocket Exhaust; Rocket Launching; Solid Rocket Propellants; Spacecraft Launching

19960008939 Central Research Inst. of Machine Building, Kaliningrad, Russia
THE IMPACT OF SPACE ROCKET LAUNCHES ON THE EARTH OZONE LAYER
Tishin, Anatoli, Central Research Inst. of Machine Building, Russia; Alexandrov, Eric L., Nauchno-Proizvodstvennoe Obedinenie Typhoon, Russia; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 9 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The paper addresses the problem of assessing the composition and quantity of substances exhausted by rockets during their trajectory flights. It demonstrates the necessity of taking into account chemically non-equilibrium processes taking place during exhaust gas flow through an engine nozzle, afterburning in the atmosphere and presence of the N2 technological impurity contained in the liquid oxygen oxidizer in the amount of 0.5 percent N2. Emission magnitudes of ozone-affecting substances by Energiya Shuttle, Zenit, Proton and MX rocket stratospheric flights are stated. It was noted that the estimated Energiya and Shuttle rocket major exhaust amounts differ from those stated in other works by one-two orders of magnitude. The stated assessment local impact on the stratospheric ozone shows that the Energiya launch effects are by an order of magnitude lower than those of the Shuttle. This fact is determined mainly by the influence of chlorine contained in ammonium perchlorate the latter being a solid fuel oxidizer. Due to that it would be reasonable to develop chlorine-free fuels or fuels with a low chlorine content. It is proposed to elaborate a procedure for calculating emissions of different substances by rockets, to publish atmospheric emission data on all the rockets in operation and to reach concord on this procedure with the leading organizations.
Author
Afterburning; Chlorine; Environment Effects; Exhaust Gases; Ozone Depletion; Rocket Exhaust; Rocket Launching; Spacecraft Launching; Spacecraft Trajectories; Stratosphere

19960008945 Army Medical Research Detachment, Wright-Patterson AFB, OH, United States
ESTABLISHING A SCIENCE-BASED ENVIRONMENTAL CLEANUP LEVEL FOR LIQUID PROPELLANT XM46
Caldwell, Daniel J., Army Medical Research Detachment, USA; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 10 p; In English; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Liquid propellant XM46 is a developmental propellant that will be used with the regenerative injection gun in the Advanced Field Artillery System. Individuals may be accidentally exposed to XM46 during operational and maintenance procedures, and there may be residual contamination of soil or water after spills are cleaned up. XM46 is moderately toxic; the primary systematic effects are the production of methemoglobin, altered liver function, and enlargement of the spleen and liver. XM46 also produces skin irritation and is a strong eye irritant. Genotoxity evaluations of XM46 were negative. XM46 was further evaluated to determine its potential to produce reproductive toxicity, such as alterations in paternal fertility, maternal pregnancy and lactation, dominant lethal effects, and growth and development of offspring. A teratology study was also undertaken to determine if XM46 causes birth defects in the developing fetus. No evidence of fetal toxicity related to XM46 exposure was noted in any of the dose groups; it was concluded that XM46 is not a reproductive toxicant or teratogen in the rat. Based on the results of these studies, a Reference Dose (RfD) was established on which to base safe maximum contaminant levels for environmental exposures. Negotiations with the U.S. Environmental Protection Agency to adopt alternative risk assessment practices are underway in an attempt to establish a scientifically defensible cleanup level.
Author
Biological Effects; Contaminants; Gun Propellants; Health; Liquid Rocket Propellants; Physiological Effects; Toxic Hazards; Toxicity

19960008956 Societe Nationale des Poudres et Explosifs, Defense Espace Div., Saint-Medard-en-Jalles, France
TEST RIG FOR SOLID PROPELLANT ROCKET MOTORS THAT REDUCES THE IMPACT OF NOISE ON THE ENVIRONMENT ***BANC DE TIR POUR MOTEUR FUSEE A PROPERGOL SOLIDE A IMPACT SONORE REDUIT SUR L'ENVIRONNEMENT***
Rat, Roger, Societe Nationale des Poudres et Explosifs, France; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 6 p; In French; See also 19960008937; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Test rig for rocket motor launching has its sound impact reduced on the environment. This conference presents data on the launching of the solid propellant rocket without harmful effect on the environment.
Author
Engine Tests; Environment Effects; Noise Reduction; Rocket Engine Noise; Rocket Engines; Solid Rocket Propellants

19960008958 Moscow Inst. of Aviation Technology; **USSR**
ROCKET ENGINES AND ECOLOGICAL PROBLEMS
Krasilnikov, E. Y., Moscow Inst. of Aviation Technology, USSR; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 5 p; In English; See also 19960008937; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Creation and employment of rocket engines and ecological problems are known to be incompatible. Nevertheless, we must aspire to this ideal situation. All specialists recognize the effect of the combustion products of liquid- and solid- fuel rocket engines on the Earth in the local aspect. But, among the scientists, so far there is no generally-acceptable point of view as to whether or not the rocket engines affect the Earth's environment in the global aspect. The paper analyzes this problem, and presents a new unusual and unexpected point of view.
Derived from text
Combustion Products; Ecology; Environment Effects; Rocket Engines

19960008968 Centre d'Achevement et d'Essai des Propulseurs et Engins, Direction des Missiles et de l'espace., Saint-Medard-en-Jalles, France
EVALUATION OF THE ENVIRONMENTAL IMPACT OF THE STATIC TESTS OF ENGINES WITH SOLID PROPELLANT ***EVALUATION DE L'IMPACT SUR L'ENVIRONNMENT DES ESSAIS STATIQUES DE PROPULSEURS A PROPERGOL SOLIDE***
Aguesse, Thomas, Centre d'Achevement et d'Essai des Propulseurs et Engins, France; Moreau, Stephane, Centre d'Achevement et d'Essai des Propulseurs et Engins, France; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 11 p; In French; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

CAEPE has been carrying out static tests of engines with solid propellant for many years. In order to authorize the square pulses of shooting, it has predictive means for modelling the impact of the shooting on the environment. Computer codes of simulation thus address the areas of acoustic harmful effects and those possibly prone to acid repercussions. These codes, which use the weather data obtained by radiosondes on the site, were gradually readjusted during tests of units of various tonnage (to strap-on booster P230 of ARIANE V). In the presentation, the emphasis was made on a model derived from the usual model of G.A. BRIGGS for the modeling of the rise of the effluents carried at high temperatures. The realism of simulations of formation of the acid rains passes indeed by taking into account this phenomenon. On the other aspects of the codes, the main references are provided.
Author
Computer Programs; Environment Effects; Prediction Analysis Techniques; Solid Propellant Rocket Engines; Solid Propellants; Static Tests

19970006912 Centro di Studi per l'Applicazione dell'Informatica all'Agricoltura, Florence, Italy
ECO-CLIMATIC CLASSIFICATIONS BY USE OF NOAA-AVHRR DATA. A CASE STUDY: TUSCANY (CENTRAL ITALY)
Petkov, L., Centro di Studi per l'Applicazione dell'Informatica all'Agricoltura, Italy; Maselli, F., Consiglio Nazionale delle Ricerche, Italy; Conese, C., Consiglio Nazionale delle Ricerche, Italy; Tacconi, G., Consiglio Nazionale delle Ricerche, Italy; Remote Sensing: A Valuable Source of Information; Oct. 1996; 8p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Eco-climatic classifications have proven to be of great utility for the planning and management of various agricultural and forestry activities. Since usual methods are often expensive and not easy to apply, remote sensing data processing has recently been proposed to identify ecologically homogeneous land units NOAA advanced very high resolution radiometer (AVHRR) data in particular have been demonstrated to be suitable for this purpose thanks to their spatial resolution and frequency acquisition. While most works in this field have dealt only with normalized difference Vegetation Index (NDVI) imagery, it has been suggested that thermal and ancillary data could also provide significant information. These considerations have been kept in mind during the present study, which concerns the eco-climatic classification of a complex Italian region by the use of NOAA NDVI and thermal images from two years in addition to ancillary data. A complete methodology was developed for the processing of this integrated data set with particular reference to the identification of suitable numbers of main and sub classes. The results obtained testify to the eco-climatic value of the product obtained.
Author
Classifications; Forest Management; Agriculture; Climatology; Remote Sensing; Spatial Resolution; Image Processing

19970023079 Bombardier, Inc., Dorval, Quebec Canada
ENVIRONMENTAL PERSPECTIVES FROM A CANADIAN AEROSPACE COMPANY
Alcorta, H. G., Bombardier, Inc., Canada; Desmarais, P., Bombardier, Inc., Canada; Feb. 1997; 4p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

In Canada, the Federal, Provincial and Municipal governments have assumed responsibilities for different aspects of establishing and enforcing environmental legislation. As a partner in the largest aerospace company in Canada, Bombardier-Canadair uses various materials and processes which are regulated, such as organic coatings, resins, sealants, solvents, deoxidizers, chromic acid anodizing, cadmium plating, chromium plating, etc. The work done at Bombardier-Canadair over the last five years concentrated in eliminating ozone depleting compounds, reducing emissions of volatile organic compounds, reducing the amount of hexavalent chromium (Cr 6+) in our effluent, and replacing hazardous air pollutants. New issues are also being addressed, such as the replacement of methylene-based chemical strippers and the replacement of electrolytic cadmium plating. This purpose of this paper is to provide an overview of the various levels of environmental legislation facing Canadian Aerospace companies in general and Bombardier-Canadair in particular. The paper also summarizes the technical problems presented by such legislation and the work done by Bombardier-Canadair and Bombardier-de Havilland to solve these problems and achieve compliance.
Derived from text
Environment Protection; Ozone Depletion; Air Pollution; Canada

19970023080 Aerospatiale, Centre Commun de Recherches Louis Bleriot, Suresnes, France
PROCEDURES FOR ENVIRONMENTAL PROTECTION: PROBLEMS AND SOLUTIONS
Cuntz, J. M., Aerospatiale, France; Bodu, J. J., Aerospatiale, France; Costes, B., Aerospatiale, France; Michelin, P., Aerospatiale, France; Marchandise, D., Aerospatiale, France; Henriot, F., Dassault Aviation, France; Druet, M., Dassault Aviation, France; Day, B., Dassault Aviation, France; Rouquet, A., Dassault Aviation, France; Feb. 1997; 6p; In French; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The following products and current fabrication procedures, which are employed in the aeronautical industry and subject to regulations for protection of the environment and human health, are described: cleaning of surfaces by organic solvents; aqueous treatments (scouring and anodization); metallic coatings; application of organic films (paints and glazes); chemical machining of metals (vapors and masks); waterproofing products; removal of agents; drying treatments and; braking products.
Derived from text
Environment Protection; Regulations; Toxic Hazards

19970023081 Defence Research Agency, Structural Materials Centre, Farnborough, United Kingdom
ENVIRONMENTALLY COMPLIANT SURFACE TREATMENT ACTIVITIES IN THE UNITED KINGDOM
Hitchen, C. J., Defence Research Agency, UK; Gostelow, C. R., Defence Research Agency, UK; Gostelow, J. C., Defence Research Agency, UK; Feb. 1997; 6p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Environmental legislation is having a major impact on surface treatment activities in the UK (UK). This paper summarizes current UK legislation and aims to show, through a specific example of relevance to the UK Ministry of Defense (MOD) work undertaken to ensure that environmental compliance is achieved. This covers the introduction of paints, with reduced solvent levels, into the various branches of the Armed Forces. and general results and conclusions from the task are summarized. Paint removal issues are also discussed with regard to UK MOD operations. Two broader case studies are also presented to demonstrate that environmental compliance does not have to involve increased costs either at the manufacturing stage or during unnecessary 'pollution clean-up' activity.
Author
Surface Treatment; Environment Protection

19970023082 Wright Lab., Systems Support Division, Wright-Patterson AFB, OH United States
OVERVIEW OF CLEANING/SURFACE PREPARATION FOR METALS IN THE US
Reinhart, T., Wright Lab., USA; Feb. 1997; 8p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Environmentally acceptable cleaning and surface pretreatment are being implemented in the US in order to reduce the costs of production and maintenance of weapon systems. The application of good business practices and decisions are central to meeting customer requirements, improving performance, reducing costs, environmental acceptability of materials and process and maintaining occupational health and safety. The key factors involved in any material or process change include, environmental acceptability, performance and affordability The use of semi-aqueous and closed system volatile organic solvent cleaning has found widespread application within the US aerospace community. Metallic surface preparations including conversion coating, anodizing, adhesive bonding or electroplating are presently being converted the those not requiring the use of hazardous and toxic materials as well as large amounts of process water. Research and development activities are presently at a high level to develop new environmentally acceptable and safe processes for the long term.
Author
Environment Protection; Pretreatment; Surface Treatment; Cleaning; Metal Surfaces; Solvents

19970023083 Aerospatiale, Toulouse, France
SURFACE TREATMENTS AND THE ENVIRONMENT: IMPACT OF REGULATIONS ON THE POLICIES OF THE AEROSPACE INDUSTRIES
Brousset, C., Aerospatiale, France; Carre, C., Aerospatiale, France; Costes, B., Aerospatiale, France; Feb. 1997; 6p; In French; See also 19970023078; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Restrictions on use of products depleting the ozone layer, such as chlorofluorocarbons (CFC113) and T111, as well as other toxic substances, such as cadmium, volatile organic compounds (COV), and chromates, and gradual substitution by less dangerous toxic materials for the protection of the environment and health, are addressed. The cost factors associated with these changes are

discussed. Aerospatiale, in partnership with French aeronautical industries, instituted a strategically original approach to control the industrial risks generated by use of these materials.
Derived from text
Aerospace Industry; Regulations; Costs; Ozone Depletion; Environment Protection; Surface Treatment

19970023084 Naval Air Warfare Center, Research and Engineering Group, Patuxent River, MD United States
US ENVIRONMENTAL TRENDS AND ISSUES AFFECTING AEROSPACE MANUFACTURING AND MAINTENANCE TECHNOLOGIES
Hartle, S. J., Naval Air Warfare Center, USA; Stephens, B. T. I., Naval Aviation Depot, USA; Feb. 1997; 12p; In English; See also 19970023078; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The exploration, development and implementation of new aerospace maintenance and manufacturing technologies is partially driven by the increasingly strict environmental regulations and issues. In the USA, innovative technologies are competing for acceptance as the new generation aerospace materials or process standards. The selection of new manufacturing or maintenance processes is largely based on environmental acceptability, but increasingly centered on efficiency, rapid implementation, monetary payback, and most importantly on the ability of the technology to improve an aircraft's mission. In the near future, human health issues may dominate new technology projects funded through environmental programs as new studies show the possibility of the health risk of extremely small quantities of airborne toxics and particulate matter.
Author
Aerospace Industry; Environment Protection; Regulations; Trends

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GEOPHYSICS

19960007228 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States
TROPOSPHERIC REFRACTIVITY PROFILES INFERRED FROM LOW ELEVATION ANGLE MEASUREMENTS OF GLOBAL POSITIONING SYSTEM (GPS) SIGNALS
Anderson, Kenneth D., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 7 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Propagation assessment tools, such as the Engineer's Refractive Effects Prediction System, provide a near real-time capability to evaluate the performance of radar and communication systems and include tactical decision aids that can be used to mitigate or exploit atmospheric effects on propagation. However, a crucial factor for these analytical tools is a thorough knowledge of the spatial distribution of refractivity. Quantifying the refractivity structure is a different problem especially in the littoral zone where the sharp contrast between land and sea strongly contributes to both spatial and temporal variability. A technique to remotely sense the vertical refractivity profile of the lower atmosphere is examined. This technique infers the refractive structure from ground-based measurements of GPS satellite signals as the satellite rises or sets on the horizon. There are obvious advantages to this concept. Results from a series of satellite-to-ground signal measurements are presented and compared to 'ground truth' measurements made using radiosondes and an instrumented aircraft.
Author
Atmospheric Effects; Global Positioning System; Refractivity; Satellite Communication; Spatial Distribution; Temporal Distribution; Troposphere

19960007230 Naval Postgraduate School, Dept. of Meteorology., Monterey, CA, United States
REMOTE MEASUREMENT OF ATMOSPHERIC REFRACTION CONDITIONS IN THE COASTAL REGION
Davidson, K. L., Naval Postgraduate School, USA; Wash, C. H., Naval Postgraduate School, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 8 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Marine atmospheric boundary layer (MABL) and ocean surface properties remotely sensed by airborne and ground-based sensors are compared with coastal in situ measured refractive conditions. Near-surface refractive conditions are influenced by near-surface turbulence (wind speeds), by surface temperature (SST), and by overlying air dryness. All the latter can be estimated within operational and research satellite data. Humidity and temperature gradients at the top of the boundary layer can be related to remotely sensed cloud properties and to ground-based infrared High Resolution Interferometer Sounder (HIS) measured profiles. Studies were performed in coastal (Norwegian, California) regions. In situ and ground-based remote data were obtained from ship mounted systems. Other remote data were from aircraft and from operational (NOAA, DMSP) and research (ERS-1) satellite borne sensors. In examined cases, remotely sensed information yields reasonable assessments of refractive conditions immediately above the surface but not of the structure at the top of the boundary layer. Remote data describe high resolution horizontal and temporal variations, important in the coastal, but not described by point measured in situ data.
Author
Air Water Interactions; Airborne Equipment; Atmospheric Refraction; Coasts; Ocean Surface; Remote Sensing; Satellite Observation; Surface Properties

19960007242 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Physics and Electronics Lab., The Hague, Netherlands
CHARACTERISATION OF ATMOSPHERIC PROPERTIES DURING MAPTIP
Vaneijk, Alexander M. J., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Bastin, Frank H., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Neele, Filip P., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Deleeuw, Gerrit, Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Injuk, Jasna, Antwerp Univ., Belgium; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 8 p; In English; See also 19960007226
Contract(s)/Grant(s): N00014-91-J-1948; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Aerosol particle size distributions were measured during the MAPTIP (Marine Aerosol Properties and Thermal Imager Performance Trial) experiment at Hr.Ms. Tydeman. Extinction coefficients were calculated using a Mie routine. The analysis shows that the TNO local MPN aerosol model accurately predicts the aerosol extinction for data in its range of validity. The applicability of the MPN model decreases outside its limits for geographical region and environmental parameters. The model is compared to the Navy Aerosol Model. The chemical composition of the aerosol during MAPTIP is discussed in terms of geography and environmental parameters.
Author
Aerosols; Atmospheric Chemistry; Atmospheric Effects; Atmospheric Models; Computer Programs; Electro-Optics; Meteorological Parameters; Size Distribution

19960007243 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States
AEROSOL PROFILES NEAR THE SEA SURFACE DURING MAPTIP
Gathman, Stuart G., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 11 p; In English; See also 19960007226; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Marine Aerosol Properties and Thermal Imager Performance (MAPTIP) experiment was designed to determine the profiles of the full size range of aerosol in the first 15 meters above the water surface under differing weather and wave conditions. Aerosol data taken during MAPTIP by NCCOSC RDT&E Div (NRaD) at the Meetpost Noordwijk (MPN) tower (52.2739 degrees N, 4.2961 degrees E) were used to determine the profile of aerosol during this period. The aerosol size distributions obtained from 1/2 hour averages were all converted to four aerosol extinction values for the wavelengths of 0.55, 1.06, 3.5 and 10.6 microns. The data obtained were shown to be from four different scenarios. First of all, during one period of very high relative humidity values, fog conditions were encountered which gave very

high extinction values. There were also times when the data were apparently contaminated by eddies from the tower which contained the exhaust from the power generator. However, most of the data came from two other regimes which could be easily separated in the data set. The times when the wind was from the north, the aerosol were more truly marine in nature. The rest of the time there was a strong continental component of the aerosol coming to the tower from the towns and factories to the east. This paper shows the profile of extinction from 12 meters to the water's surface for the oceanic type of aerosol as it is affected by the wind and other factors. Profiles of relative humidity from measurements and models are used to determine the extent to which extinction profiles would be modified by the growth of hygroscopic particles. A log curve is fitted to the open ocean data from MAPTIP to describe the variation in extinction from shipboard levels to the tips of the surface waves.
Derived from text
Aerosols; Air Water Interactions; Imaging Techniques; Ocean Surface; Size Distribution; Temperature Effects; Thermal Mapping; Weather

19960007244 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States
AEROSOL MAPS MADE DURING MAPTIP
Gathman, Stuart G., Naval Command, Control and Ocean Surveillance Center, USA; Jensen, Douglas R., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 7 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

In coastal areas, the simplifying assumptions of horizontal homogeneity used in open ocean analysis are not always useable. Various human-generated aerosol sources such as towns and industrial centers can provide a complex portrait of merging plumes of non-natural aerosols which are advected out to the littoral zones. The extensive meteorological and aerosol measurements made during the Marine Aerosol Properties and Thermal Imager Performance (MAPTIP) experiment provided an ideal opportunity to view how these aerosols were advected from their sources to the littoral zone of the North Sea. MAPTIP was conducted along the Dutch coast in October/November 1993. The NCCOSC, RDT&E DIV (NRaD) instrumented Navajo aircraft flew two star pattern flights a day during the experiment at altitudes below 500 feet. During these flights, aerosol size distribution measurements along the flight path were being continuously recorded. These measurements were utilized for making aerosol concentration maps of the various sized aerosol groups. This paper shows the mesoscale effects of aerosol advection making the marine boundary layer in a littoral zone much more complicated than that of an open ocean.
Author
Aerosols; Coasts; Homogeneity; Marine Meteorology; Meteorological Parameters; Oceans; Thermal Mapping

19960007245 Manchester Coll. of Science and Technology, Dept. of Pure and Applied Physics.; **UK**
UMIST OBSERVATIONS OF ACCUMULATION MODE AEROSOL CONCENTRATIONS AND COMPOSITION DURING MAPTIP
Smith, Michael H., Manchester Coll. of Science and Technology, UK; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 8 p; In English; See also 19960007226; Sponsored by UK Defence Research Agency; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The primary contribution of the UMIST Group to the MAPTIP campaign consisted of measurements of the concentration and composition of the accumulation mode aerosol (0.05 less than r less than 0.1 microns). Direct measurements of soot carbon concentrations, by means of an aethalometer, demonstrated its ubiquitous presence throughout most of the trial. A thermal analytical technique was employed to determine the size-differential composition of the aerosol and confirmed that these soot carbon particles dominated the aerosol spectrum below about 0.1 microns in radius, with substantial particulate sulphate contributions for radii from 0.1 to 0.5 microns. The light winds ad short fetches during most of the campaign meant that the sea salt contribution to this small aerosol was generally slight. However, a brief period of northerly winds during the measurement period gave significant sea salt loadings for radii from 0.2 to 0.5 microns.
Author
Aerosols; Concentration (Composition); Particle Size Distribution; Thermal Mapping

19960007248 Naval Postgraduate School, Dept. of Meteorology., Monterey, CA, United States
SURFACE LAYER TURBULENCE AND AEROSOL PROFILES DURING MAPTIP
Davidson, K. L., Naval Postgraduate School, USA; Frederickson, P. A., Naval Postgraduate School, USA; Deleeuw, Gerrit, Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 9 p; In English; See also 19960007226; Sponsored by NRaD Contract(s)/Grant(s): N00014-91-J-1948; NATO AC/243-6056; NATO AC/243-6092; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Naval Postgraduate School (NPS) and the TNO Physics and Electronics Laboratory (TNO-FEL) deployed in situ sensors near and on Meetpost Noordwijk (MPN) during MAPTIP to describe the surface layer processes and also to evaluate models for near-surface aerosol profiles. Vertical profiles of aerosol counts were measured on the MPN tower by TNO-FEL with Rotorod impaction samplers. The aerosol distribution measurements were made for 10 radius bins, with centered radii ranging from 6.5 to 75 microns. Atmospheric surface-layer turbulence and stratification were measured by NPS from an instrumented buoy that was located a short distance from MPN. Existing models relate aerosol profiles to source, sink, and turbulent transport processes. The assumed source process is bursting air bubbles at the surface. The removal processes are turbulent deposition and gravitational fallout. Turbulent transport is described by the friction velocity and the near-surface stratification. The combined buoy and MPN data sets are shown to provide valuable descriptions of surface layer properties during the variable period from 26 October through 3 November. Results from eleven profile sampling periods were compared with model predictions for which buoy measured parameters and aerosol sizes were inputs. The predicted concentration often decreased more with height than observed. This is believed due to the coastal input to the aerosol source since advected aerosol would reduce influences on gradient of bubble production at the surface.
Author
Aerosols; Air Water Interactions; Atmospheric Turbulence; Ocean Surface; Particle Size Distribution; Surface Layers; Turbulence

19970006929 Naval Postgraduate School, Dept. of Meteorology, Monterey, CA United States
MULTISPECTRAL REMOTE SENSING OF THE COASTAL ATMOSPHERIC BOUNDARY LAYER
Wash, C. H., Naval Postgraduate School, USA; Davidson, K. L., Naval Postgraduate School, USA; Jordan, M. S., Naval Postgraduate School, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 6p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Coastal marine atmospheric boundary layer (MABL) properties derived from satellite data are compared with coastal in situ aircraft and rawinsonde measured properties. A multispectral approach using visible and infrared (IR) data is tested to estimate indirectly important variables such as depth of the MABL. In situ data are obtained from aircraft, ship mounted systems, and from shoreline stations. In the examined cases, remotely sensed information yields reasonable assessments of the height of the top of the boundary layer as well as conditions immediately above the surface. Remote data describe high resolution horizontal/temporal variations, important in the coastal regions, but not described by point measured data. Limitations of the approach due to sun glint, continental aerosols and more complex MABL structures are discussed also.
Author
Aerosols; Air Water Interactions; Atmospheric Boundary Layer; Remote Sensing; Temporal Distribution; High Resolution; Marine Environments; Advanced Very High Resolution Radiometer

19980210667 Defence Evaluation Research Agency, Radio Science Propagation Group, Malvern, United Kingdom
NON-LINEAR PREDICTION OF IONOSPHERIC PARAMETERS IMPORTANT FOR FORECASTING THE BATTLESPACE ENVIRONMENT
Francis, N. M., Defence Evaluation Research Agency, UK; Brown, A. G., Defence Evaluation Research Agency, UK; Akram, A., Defence Evaluation Research Agency, UK; Cannon, P. S., Defence Evaluation Research Agency, UK; Broomhead, D. S., Manchester Coll. of Science and Technology, UK; Apr. 1998; 7p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Modelling results from a programme to improve the accuracy of the prediction of ionospheric parameters are presented. Ionosphenc conditions impact upon communications, navigation/GPS, satellite operations and surveillance radar operations. As a result, ionosphenc predictions have an important bearing upon the specification of the battlespace environment. The paper presents a novel and robust technique that can cope with the problems of noise and non-contiguity that are endemic to solar-terrestrial data sets. The method of using non-linear radial basis function (RBF) neural networks (NNs) to model the noon-day variation of the critical frequency of the F2 layer of the ionosphere, foF2, is investigated. A technique based upon singular value decomposition is also adopted for the purposes of noise reduction. The performance of the model is compared with the results obtained from the reference persistence model predictions. Consecutive noon-day foF2 values from 1957 to 1990 from the Slough ionosonde station (UK) are used to train and test the model. Predictions are made for timescales of one to thirty days ahead, using both the RBF and persistence models. Relative performance is quantified using root mean square error (RMSE) between the RBF and persistence prediction time series compared with the actual time series, over the testing interval. It is found that RBF NNs offer a significant improvement, approximately 60%, over the performance of the reference persistence model.
Author
Surveillance Radar; Military Technology; Military Spacecraft; Global Positioning System

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METEOROLOGY AND CLIMATOLOGY

19960007241 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States
SUMMARY OF THE MARINE AEROSOL PROPERTIES AND THERMAL IMAGER PERFORMANCE TRAIL (MAPTIP) ORGANIZED BY NATO AC/243 PANEL 4/RSG.8 ON ATMOSPHERIC PROPAGATION EFFECTS ON ELECTRO-OPTICAL SYSTEMS, 11 OCTOBER - 5 NOVEMBER 1993
Jensen, D. R., Naval Command, Control and Ocean Surveillance Center, USA; Deleeuw, G., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Vaneijk, A. M. J., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 10 p; In English; See also 19960007226
Contract(s)/Grant(s): N00014-91-J-1948; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

During the fall of 1993 a field experiment entitled Marine Aerosol Properties and Thermal Imager Performance Trial (MAPTIP) was conducted by NATO AC/243 Panel 04/RSG.8 and 04/RSG.5 in the Dutch coastal waters. The objectives of the trial were (1) to improve and validate vertical marine aerosol models by providing an extensive set of aerosol and meteorological measurements, within a coastal environment, at different altitudes and for a range of meteorological conditions; (2) to make aerosol and meteorological observations in the first 10 m of the ocean surface with a view to extending existing aerosol models to incorporate near-surface effects; and (3) to assess marine boundary layer effects on thermal imaging systems. Calibrated targets at different altitudes were observed to the maximum observable range under a wide variety of conditions in both the 3-5 and 8-12 micron bands. These data will be used for the development and validation of IRST models and IR ship signature models with the view of determining the effects of marine-generated aerosols, turbulence, and meteorological profiles on their performance. Aerosol and meteorological instruments, as well as thermal imagers and calibrated targets, were utilized on the Dutch Meetpost Noordwijk (MPN) tower, at a Katwijk Beach Station, the Hr. Ms. Tydeman oceanographic vessel, on a Lynx helicopter, on a Dutch P3 Orion, on the NCCOSC RDT&E DIV (NRaD) airborne platform, and on buoy systems. This network of instrumentation has provided a comprehensive data base of aerosol size distribution profiles and relevant meteorological variables throughout the marine atmospheric boundary layer. Thermal imagery was included to provide ground truth for assessing the low-level propagation effects near the ocean surface. Measurements were made of atmospheric turbulence and refractivity effects in the IR and RF bands to assess the marine boundary layer effects on the degradation of thermal images. Calibrated targets at different altitudes were observed to the maximum observable range under a wide variety of conditions in both the 3-5 and 8-12 micron bands. These data are to be used for the development and validation of IRST models and IR ship signature models for determining the effects of marine-generated aerosols, turbulence, and meteorological profiles on their performance.
Author
Aerosols; Airborne Radar; Atmospheric Models; Atmospheric Refraction; Coasts; Imaging Techniques; Infrared Radar; Infrared Tracking; Marine Meteorology; Meteorological Parameters; Ocean Surface; Temperature Effects; Thermal Mapping

19960016912 Aerospace Corp., Los Angeles, CA United States
A WEATHER FORECAST UTILITY MODEL FOR MILITARY MISSIONS
Bohlson, J. S., Aerospace Corp., USA; Reid, R. W., Aerospace Corp., USA; Oct. 1995; 18p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The weather FORecast Utility Model (FORUM) is being developed to analyze the benefit of forecast data to the operational commander in the field. to be relevant to a given operation, such a model must reflect the concept of operations (CONOPs) of the mission under study. Thus, the modeler must understand the operation's decision process, and, in particular, how weather data influences that process. Toward that end, the description of FORUM is illustrated by an air munitions mission, wherein both the go/no-no decision and a tactical payload alternative are decided on the basis of weather parameter predictions. Single target mission effectiveness is cast in the form of sorties used and days needed to complete the mission which, in this case, is ground target destruction. For multiple weapon/target site scenarios, effectiveness can also be expressed as targets killed within a fixed period of time or resources needed to negate a fixed number of targets. For multitarget scenarios, the force multiplicative effects of correct forecast data is manifested via such metrics. The weather parameter data being used to characterize forecast accuracy is the product of some very detailed analyses and simulation of the forecast process from satellite measurement through weather parameter prediction. The Forecast Systems Laboratory (FSL) of the U.S. National Oceanic and Atmospheric Administration (NOAA) is providing satellite measurement simulation and weather parameter prediction for a sample case within the continental USA. The statistical characterization of this data provides some of the input for the FORUM model.
Derived from text
Weather Forecasting; Data Flow Analysis; Models; Military Operations; Satellite Imagery; Accuracy; Applications Programs (Computers); Decision Making; Mission Planning

19970006914 Naval Air Warfare Center, Geophysics Branch, Point Mugo, CA United States
SHORT-TERM PERSISTENCE OF LOW CLOUD FEATURES
Helvey, Roger A., Naval Air Warfare Center, USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 4p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Considerable structure is present in low cloud features seen in weather satellite images of the region offshore southern California. From geostationary imagery, it is evident that translation of this structure is largely responsible for the variability in cloudiness experienced at any fixed point. This report describes the use of an interactive computer technique for tracking cloud features and to determine the

transport field. Statistics related to the persistence of cloud features are obtained to assess the possible value of extrapolation of preexisting patterns in forecasting conditions at any fixed point for a few hours.
Author
Computer Techniques; Satellite Imagery; Meteorological Satellites; Weather Forecasting; Image Processing; Remote Sensing; Cloud Physics; Pattern Recognition

19970026427 Aerospace Corp., Los Angeles, CA United States
INTERPRETATION OF PASSIVE MICROWAVE RADIANCES FOR TACTICAL APPLICATIONS: CURRENT AND FUTURE CAPABILITIES OF THE DEFENSE METEOROLOGICAL SATELLITE PROGRAM (DMSP)
Boucher, Donald J., Aerospace Corp., USA; Thomas, Bruce H., Aerospace Corp., USA; Holliday, Charles, Air Force Global Weather Central, USA; Jun. 1997; 12p; In English; See also 19970026418; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The DMSP program is the Department of Defense polar satellite system chartered to provide high quality meteorological data to strategic planners at major military command centers such as Air Force Global Weather Central in Omaha, Nebraska, as well as to tactical forces in the field. DMSP has a long history of flying state-of-the-art microwave instruments that derive vertical temperature and water vapor profiles, and detailed surface and near-surf ace properties such as soil moisture, and ocean surface wind speed. These microwave sensors compliment the prime sensor, the Operational Linescan System (OLS). The OLS is a cross-track scanning cassegrain telescope that samples in the visible and infrared wavelengths, featuring near constant horizontal resolution across the scan. Advanced Very High Resolution Radiometer (AVHRR) channel 1 at 0.4-0.6 microns (1.1 Km resolution at nadir only). At the edge of scan, the AVHRR pixels become elongated, whereas the OLS remains nearly constant. The data from Figure 1 were taken at the Aerospace real-time groundstation with DMSP Flight 11 transiting at 1450Z on 26 April of 1995, and NOAA 12 at 1541Z on the same day. The coverage of these passes were virtually identical, but the difference in resolution between the two sensors is very apparent. The OLS has an additional capability of being able to image in the visible at night making use of reflected moonlight. Figure 2 is an example of the low light capability showing Japanese fishing fleets in the Pacific off the coast of Japan.
Derived from text
Advanced Very High Resolution Radiometer; Defense Program; DMSP Satellites; Microwave Sensors; NOAA 12 Satellite; Real Time Operation

19970026428 Aerospace Corp., El Segundo, CA United States
SMALL METEOROLOGICAL SATELLITES FOR NATO MILITARY OPERATIONS
Duclos, D. P., Aerospace Corp., USA; Feddes, R. G., Aerospace Corp., USA; Gurevich, G. E., Aerospace Corp., USA; Jun. 1997; 10p; In English; See also 19970026418; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The planning and effectiveness of military operations can often be greatly enhanced by timely meteorological information. This information is particularly important during rapidly changing weather conditions and can be critical to the success of military operations in a dynamic tactical environment. Due to the ever increasing pace of modern high technology warfare, the revisit time of low orbit meteorological satellites is inadequate to provide the war fighter with timely weather data.
Author
Meteorological Parameters; Meteorological Satellites; Meteorology; Military Operations

48 OCEANOGRAPHY

19950026720 Saint Petersburg Inst. of Aerospace Instrumentation, Saint Petersburg, Russia
SEA WAVE PARAMETERS, SMALL ALTITUDES AND DISTANCES MEASURERS DESIGN FOR MOVEMENT CONTROL SYSTEMS OF SHIPS, WING-IN-SURFACE EFFECT CRAFTS AND SEAPLANES
Nebylov, A. V., Saint Petersburg Inst. of Aerospace Instrumentation, Russia; Vanayev, A. P., Saint Petersburg Inst. of Aerospace Instrumentation, Russia; Chernyavets, V. V., Saint Petersburg Inst. of Aerospace Instrumentation, Russia; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 12 p; In English; See also 19950026705; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

Advanced methods and means of controlled sea vehicle moving parameters and sea-way ones measurement are considered. Both directly measuring tasks and possibilities of control quality increasing of displacement and undisplacement ships and sea flying vehicles under conditions of active wave disturbances are analyzed. Design principles, some structural features and expected quality characteristics of device, being developed, for meter altitudes and distances measuring based on special phase radioaltimeter and inertial sensor integration are observed. When functioning in the sea-waves profile tracking mode, high measuring accuracy of sea-way and vehicle vertical moving parameters is provided. The mounting of several devices both on the left and on the right sides of vehicle allows to reconstruct the field of sea wave disturbances and to check roll and pitch parameters and draught or clearance as well. The conditions to be fulfilled for determining the main sea wave spread direction are investigated.
Derived from text
Altitude; Control Systems Design; Design Analysis; Directional Control; Distance; Seaplanes; Surface Waves; Water Waves

19970006901 Centre National d'Etudes Spatiales, Toulouse, France
TOPEX POSEIDON FOLLOW-ON RADAR ALTIMETER DESIGN AND DEVELOPMENT STATUS
Escudier, Philippe, Centre National d'Etudes Spatiales, France; Raizonville, Philippe, Centre National d'Etudes Spatiales, France; Carayon, Guy, Centre National d'Etudes Spatiales, France; Thierry, Pierre de Chateau, Alcatel Espace, France; Remote Sensing: A Valuable Source of Information; Oct. 1996; 2p; In English; See also 19970006887; Copyright Waived; Avail: Issuing Activity; Abstract Only; Abstract Only

The TOPEX POSEIDON follow-on (TPFO) mission is a continuation of the present TOPEX POSEIDON mission, whose major aim is to observe the ocean circulation on a large scale basis in terms of space and time. The data provided by the TOPEX mission have a level of accuracy never reached before and allow a continuous survey of the ocean particularly worthy for the scientists involved in oceanographic and in climate related studies.
Author
Ocean Currents; Poseidon Satellite; Topex; Radio Altimeters; Remote Sensing; Satellite Altimetry

19970006915 Ohio State Univ., Byrd Polar Research Center, Columbus, OH United States
ELECTROMAGNETIC PROPERTIES OF SEA ICE
Jezek, Kenneth C., Ohio State Univ., USA; Remote Sensing: A Valuable Source of Information; Oct. 1996; 2p; In English; See also 19970006887; Copyright Waived; Avail: Issuing Activity; Abstract Only; Abstract Only

This paper reviews research completed by a team of investigators as part of an accelerated research initiative on the electromagnetic (EM) properties of sea ice. The objectives of the program are: to understand the mechanisms and processes that link the morphological physical and electromagnetic properties of sea ice; develop and verify predictive models for the interaction of visible, infrared, and microwave radiation with sea ice; develop and verify inverse scattering techniques applicable to problems involving the interaction of EM radiation with sea ice. Guiding principles for the activity have been first that all EM data are supplemented by careful

physical property data (salinity, density, roughness for example) and second, that broad spectral data be acquired in as near simultaneous a fashion as possible.
Author
Sea Ice; Electromagnetic Properties; Emission Spectra; Infrared Radiation; Inverse Scattering; Prediction Analysis Techniques; Remote Sensing

52
AEROSPACE MEDICINE

19950023206 Institute of Aviation Medicine, Oslo, Norway
EFFECT OF HYPOXIA ON ARTERIAL BLOOD GASES IN SUBJECTS WITH LUNG DYSFUNCTION
Ryg, Morten, Institute of Aviation Medicine, Norway; Christensen, Carl C., Institute of Aviation Medicine, Norway; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 14 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

Although air transportation is an efficient way of evacuating casualties out of combat zones, even the mild hypoxia in a pressure cabin may adversely affect the oxygen supply of subjects whose lung function is compromised. Obviously, the wounded are difficult to study systematically. It is, however, possible to evaluate pulmonary limitations of oxygen transport by investigating persons with various lung diseases. This paper presents the effects of very light physical work in hypoxia on subjects with chronic obstructive lung disease (COPD). These patients are characterized by obstruction of the airways, resulting in low expiratory air flow rates, and low maximal ventilation rates (Cotes 1993). We analyze the consequences of inadequate alveolar ventilation and increased resistance to diffusion in the lung for oxygen partial pressures in alveoli and arterial blood, and on arterial oxygen saturation. We also try to evaluate the usefulness of standard clinical tests in predicting susceptibility of lung patients to hypoxia.
Derived from text
Air Transportation; Blood; Casualties; Evacuating (Transportation); Hypoxia; Lungs; Patients; Pressurized Cabins

19950023208 Hellenic Air Force General Hospital, Athens, Greece
FLIGHT NURSE SCHOOL IN THE HELLENIC AIR FORCE
Papastogiannidou, KAL., Hellenic Air Force General Hospital, Greece; Katsika, ALEX., Hellenic Air Force General Hospital, Greece; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 5 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The necessity of specialized nursing personnel for air evacuated patients in peace and war time led Medical Service of the Hellenic Air Force (HAF) to train officer nurses in the USA F.N. School in order to create a similar school in our country. This School was established in 1988 and the first FN's graduated the same year. At this moment, the training courses are for officers with a near future schedule for petty officers. The structure and performance of school conducted in accordance to US FN School in Brooks AFB San Antonio TEXAS, corresponded to the needs and abilities of our country. The ultimate purposes concerning the foundation of the school are: (1) to advance the quality of nursing care; (2) to install the minimum demands - standards of care for FN; 3) to access FN nursing enlightment to all levels of medical personnel; (4) the readiness to respond in every emergency condition involving air evacuation demands in agreement with an appropriate program; (5) the attachment of education to all FN; and (6) to advance assurance quality with a predetermined procedure. Course is mandatory and operates on a theoretical base with a minimum of practical application. The experiences gained from FN during the involvement in three (3) scheduled air drills were fewer than expected. Flight nursing offers a unique and broad field to professional nursing with an opportunity to serve patients, community, integrating nursing as a basic part of aerospace medicine.
Author
Education; Evacuating (Transportation); Flight Nurses; Medical Personnel; Medical Services; Schools

19950027631 Royal Air Force Inst. of Aviation Medicine, Farnborough, United Kingdom
NEGATIVE TO POSITIVE GZ ACCELERATION TRANSITION
Prior, A. R. J., Royal Air Force Inst. of Aviation Medicine, UK; AGARD, Current Concepts on G-Protection Research and Development; May 1, 1995, 8 p; In English; See also 19950027629; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Sustained negative Gz acceleration is an uncommon stress; it is poorly tolerated by the pilot, the airframe is normally stressed to only -3 Gz, and operationally there is no defined advantage for performing such a maneuver. However, during repeated pulls of high +Gz it is common practice to push negative Gz while regaining aircraft energy prior to another high G turn. During the period of negative G, which might be for only 1 or 2 seconds, there is the rapid development of bradycardia, peripheral vasodilation, and the likelihood of cardiac arrhythmias. In this physiological state the pilot then pulls positive G giving rise to profound changes in cerebral perfusion and a marked reduction in G tolerance. The use of anti-G trousers reduces the magnitude of this effect but there remains a significant lowering of G tolerance which, it is suggested, might contribute to the genesis of G-induced loss of consciousness.
Author
Acceleration Stresses (Physiology); Acceleration Tolerance; Aerospace Medicine; Aircraft Maneuvers; Gravitational Physiology; High Acceleration; Physiological Effects

19950027635 Air Force Inst. of Aviation and Space Medicine, Moscow, Russia
INCREASE OF HIGH-SUSTAINED +G(Z) TOLERANCE AT THE EXPENSE OF PILOT'S WORKING POSTURE CHANGE
Stupakov, G. P., Air Force Inst. of Aviation and Space Medicine, Russia; Khomenko, M. N., Air Force Inst. of Aviation and Space Medicine, Russia; AGARD, Current Concepts on G-Protection Research and Development; May 1, 1995, 12 p; In English; See also 19950027629; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

This lecture summarizes practical experience and results of theoretical investigations in the field of anti-Gz protection of flyer in high performance fighter-aircraft. The physiological and ergonomical issues are examined of implementation in aerospace flying practice of the anti-G variable geometry seat, which is aimed at the prophylaxy of adverse effects of high sustained, rapid onset rate longitudinal (+Gz), lateral (Gy), and combined (Gz/Gy) accelerations. Presented are the results of estimation of protective efficiency for variable geometry seat, received at multiple centrifuge tests, as well as its advantages with reference to prolonged flights, which were discovered in ground flight simulator experiments. There are elucidated the main physiological particularities of effects of lateral Gy and combined (Gz/Gy) aerial combat maneuvering accelerations. The applicability of variable geometry reclining seat is verified for prevention of some deleterious effects of hypergravitation of flyer's organism. Significant role is shared to physiologo-hygienic aspects of flyer's articulate seat in context with arrangement scheme for flight cabin workstation in high performance fighter aircraft.
Author
Acceleration Protection; Acceleration Tolerance; Aerospace Medicine; Aircraft Pilots; High Acceleration; Human Factors Engineering; Seats; Sitting Position; Supine Position

19950027636 Department of the Air Force, Brooks AFB, TX, United States
NEW ADVANCES IN PHYSIOLOGICAL MEASUREMENTS DURING HIGH-G: TECHNOLOGY
Balldin, Ulf I., Department of the Air Force, USA; AGARD, Current Concepts on G-Protection Research and Development; May 1, 1995, 10 p; In English; See also 19950027629; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

New noninvasive techniques for measuring cardiovascular parameters have been introduced to the acceleration research in centrifuge and in flight in fighter aircraft. Transcranial Doppler blood flow velocity measurements have been used in the centrifuge to detect brain blood flow changes during high G. As probe movements during high G is a problem, a remote control probe system has been developed and tested for better accuracy. Infrared spectrophotometry has been tested during increased G, but further development is required. Ear opacity blood volume measurements of circulatory endpoints during high G has been re-introduced. The use of Finapres or similar equipment to measure finger blood pressure has shown to be a very effective tool in acceleration research, both in the centrifuge and in flight, when used properly. Impedance plethysmography has also shown to be a useful tool in acceleration research. Doppler ultrasound

blood flow measurements and echocardiography are difficult to use at high G-level, if new robotic techniques are not developed. Subjective scales for ratings of perceived exertion during testing of G-protecting measures or during centrifuge fatigue studies seem to be valuable tools in acceleration research and may help to avoid the need for maximal tests in the centrifuge and thereby discomfort and injuries.
Author
Aerospace Medicine; Bioinstrumentation; Blood Flow; Blood Pressure; Blood Volume; Cardiac Output; Flow Measurement; Nonintrusive Measurement; Physiological Tests; Pressure Measurement; Velocity Measurement

19950027637 Defence and Civil Inst. of Environmental Medicine, North York Ontario, Canada
METHODS FOR MEASURING PHYSIOLOGICAL RESPONSES AND PROTECTION IN MAN EXPOSED TO HIGH +G(Z)
Buick, F., Defence and Civil Inst. of Environmental Medicine, Canada; Wood, E. H., Mayo Foundation, USA; Pecaric, M., Defence and Civil Inst. of Environmental Medicine, USA; Maloan, J., Defence and Civil Inst. of Environmental Medicine, USA; AGARD, Current Concepts on G-Protection Research and Development; May 1, 1995, 15 p; In English; See also 19950027629; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

The often-used subjective measurements of +Gz tolerance are inadequate because they are prone to subjective bias and cannot document the time-dependent changes in the reacting physiology. This lecture describes noninvasive, objective measurements used to measure the human subject's physiological status, to monitor physiological reactions in order to compare the +Gz protective value of various +Gz countermeasures, and to measure endpoints which will guide the termination of +Gz exposure.
Author
Acceleration Tolerance; Aerospace Medicine; Bioinstrumentation; Gravitational Physiology; High Acceleration; Human Centrifuges; Physiological Responses; Physiological Tests

19960003875 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Physics and Electronics Lab., The Hague, Netherlands
CALCULATING THE 3-D ABSORBED POWER DISTRIBUTION INSIDE A HUMAN BODY THAT IS ILLUMINATED BY AN INCIDENT EM FIELD USING THE WCG-FFT METHOD
Zwamborn, A. Peter M., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 5 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

During the past several years considerable effort has been put into the development of computational techniques for handling the scattering and diffraction of electromagnetic waves by an object. We can distinguish between global techniques (e.g., the use of wave function expansion and integral equation) and local techniques (finite-difference and finite-elements methods). In this paper we present a global technique to solve the full three-dimensional scattering problem by strongly inhomogeneous objects. This domain-integral is formulated in the frequency-domain. The strong form is weakened by using appropriate test functions and expansion functions. Subsequently, the domain-integral equation obtained is then solved using an iterative Conjugate Gradient scheme combined with an efficient computation of the convolutional integral involved by using the Fast Fourier Transform algorithm (WCG-FFT method). In order to show the accuracy of the method with the scattering problem by an inhomogeneous dielectric sphere with the Mie-series solution. Then, numerical computations are carried out on a MRI-scan generated model of a human body inside a metallic enclosure with apertures. Here, we present the absorbed power density inside the human body.
Author
Algorithms; Conjugate Gradient Method; Electromagnetic Wave Transmission; Fourier Transformation; Human Body; Integral Equations; Mie Scattering; Wave Diffraction; Wave Functions

19960023131 Institute of Aviation Medicine, Fuerstenfeldbruck, Germany
REACTION TIME AND THE EEG UNDER HYPERVENTILATION
Freund, Wolfgang, Institute of Aviation Medicine, Germany; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 24-1 - 24-8; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

EEG recordings at rest and during controlled hyperventilation (HV) with simultaneous recording of reaction time measurements taken from 59 pilots and candidates in the German Air Force Institute of Aviation Medicine (GEAF IAM) are used to investigate: the correlation of visible EEG changes during HV and changes of cognitive functions; and the feasibility of two different methods of measuring the CO2 (infrared absorption gas analyzer vs. solid body ceramic transdermal electrode) during this experiment. Under HV the CO2 decreases from a median of 37 at rest to 22mm Hg during HV. The amplitude of the EEG activity increases as the main frequency decreases. No paroxysmal activity is recorded. Reaction time increases markedly under HV (from 184ms to 226ms). Surprisingly, no correlation shows between EEG changes and reaction time. Both methods of CO2 measurement prove their feasibility, while the gas analyzer is faster and easier to operate. The implications of these findings are discussed.
Author
Electroencephalography; Hyperventilation; Aerospace Medicine

19960023132 Air Force Hospital (251th), Athens, Greece
PHYSIOLOGICAL VESTIBULAR LIMITATIONS OF MOTION PERCEPTION IN AVIATION ENVIRONMENT
Diamantopoulos, I. I., Air Force Hospital (251th), Greece; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 25-1 - 25-19; In English; See also 19960023107; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Perception of angular & linear acceleration provides together with vision the fundamental cues for situational awareness in aviation environment. Therefore, the function of the otoliths & the semicircular canals as the end-organ of balance and their perception limitations play an important role in a flight environment employing mainly high performance aircraft. This paper addresses the need to identify & provide the physiological basis for the vestibular limitations of motion perception which accounts for several disorientation illusions. Under this view, certain areas of flight configuration envelope known as precipitators of illusions are outlined and the consequent most common vestibular illusions are attributed to their physiological basis. Vestibular behavior continuoum is also outlined both in a non-IG environment and in Motion Sickness. The danger upon flight safety imposed by the vestibular function limitations can be alleviated by proper training, selection & noumerous technology aids integrated in modern cockpits.
Author
Vestibules; Semicircular Canals; Precipitators; Physiology; Motion Perception; Flight Safety; Aerospace Medicine

19960053795 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
NEUROLOGICAL LIMITATIONS OF AIRCRAFT OPERATIONS: HUMAN PERFORMANCE IMPLICATIONS *LES LIMITATIONS NEUROLOGIQUES DES OPERATIONS AERIENNES: LES CONSEQUENCES POUR LES PERFORMANCES DES EQUIPAGES*
Neurological Limitations of Aircraft Operations: Human Performance Implications; Apr. 1996; 316p; In English; In French, 9-12 Oct. 1995, Cologne, Germany; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19960053796 through 19960053827
Report No.(s): AGARD-CP-579; ISBN 92-836-0027-4; No Copyright; Avail: CASI; A14, Hardcopy; A03, Microfiche

These proceedings include the Technical Evaluation Report, three Keynote Addresses, 33 solicited papers and four special session papers of the Symposium sponsored by the AGARD Aerospace Medical Panel and held at the Deutsche Forschunosanstalt fur Luft- und Raumfahrt, Linder Hohe, Cologne, GE from 9-12 October 1995. NATO air operations in the future will have improved capabilities for mobility, flexibility, rapid augmentation and situation awareness, The rapid changes and sophisticated innovations taking place in technology imply that air warfare will become more knowledge intensive and, accordingly, more dependent on a well conditioned nervous system. Advancements in technology are also driving air and the concomitant support operations into the outer limits of human mental and physical endurance. There is also the requirement of doing more work with fewer resources. The purpose of this Symposium was to address some of the factors that impose limitations on the nervous system, and to consider the practical challenges for enhancing neuro-

logical performance in such operational conditions as described above. The papers addressed neurological limitations imposed by: (1) the Gz environment; (2) the hypoxia environment; (3) disease and trauma; (4) neurosensory limitations; (5) fatigue and sleepiness in workload; (6) stress effects; and (7) sustained operations. The practical challenges in enhancing neurological performance were addressed for: (1) heavy jet operations; (2) rotary wing operations; (3) air traffic control operations; and (4) ground and support operations. These proceedings will be of interest to those concerned with the health and safety of personnel in air and support operations, and the aerospace scientist wanting a review of relevant research in the field of air operations neuroscience.
Author
Warfare; Aerospace Medicine; Conferences; Flight Operations; Human Performance; Hypoxia; Nervous System; Neurology; Physical Fitness; Workloads (Psychophysiology)

19960053796 Defence and Civil Inst. of Environmental Medicine, North York, Ontario Canada
NEUROLOGICAL INFLUENCE IN PUSH-PULL EFFECT
Banks, R. D., Defence and Civil Inst. of Environmental Medicine, Canada; Goodman, Len S., Defence and Civil Inst. of Environmental Medicine, Canada; Apr. 1996; 10p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

During straight and level flight, aircraft occupants are exposed to the normal acceleration force of gravity, that is +1 Gz. Evolutionary development of homeostatic control of blood pressure (BP) via neurological and cardiovascular mechanisms occurred under the continuing influence of +1 Gz during walking or sitting. Thus, humans have not yet evolved mechanisms to compensate for significant excursions from +1 Gz. Aircraft occupants are frequently exposed to short duration accelerations other than +1 Gz. Air turbulence, for example, exposes occupants to short (up to O.5s) exposures to Gz. Coordinated banked turns in jet aircraft expose occupants to sustained increases in +Gz. Nose-down, or 'bunt' maneuvers expose occupants to relative -Gz (that is, Gz that is less than +1 Gz). Understanding of the effects of exposures to variations in Gz is incomplete. Because sustained increases in +Gz occur commonly in flight and can be studied in laboratories with the use of human centrifuges, much work has been accomplished. However, research conducted on human centrifuges commonly suffers from the bias of a starting baseline of +1.4 Gz, a condition that seldom exists in actual flight. Much less is known of the effects of increased +Gz when the starting condition is less than +1.4 Gz. The few studies that report on Gtolerance when +Gz baseline varies are preliminary, but have demonstrated that tolerance to +Gz decreases more when preceding Gz is relatively more negative. This effect, termed the 'push-pull effect', increases with increased time of exposure to preceding relative -Gz. In-flight studies have shown that a proper anti-g straining maneuver (AGSM) and/or g-suit inflation only partially counters push-pull effect. The recent fatal crash of a Canadian Forces CF-18 due to push-pull effect has highlighted the inadequacies of current protection strategies. Prevention of similar accidents requires completing our understanding of acceleration physiology. As a rationale for future research efforts aimed at achieving this understanding, this paper discusses the possible neuro-cardiovascular processes involved in pushpull effect.
Derived from text
Acceleration Tolerance; Exposure; Gravitation; Jet Aircraft; Neurology; Prevention; Protection

19960053797 Defence and Civil Inst. of Environmental Medicine, North York, Ontario Canada
SEIZURE ASSOCIATED WITH G-LOC: A POTENTIALLY FATAL OCCURENCE
Gray, G. W., Defence and Civil Inst. of Environmental Medicine, Canada; Paul, M. A., Defence and Civil Inst. of Environmental Medicine, Canada; Neurological Limitations of Aircraft Operations: Human Performance Implications; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

G-induced loss of consciousness (G-LOC) is a potential aeromedical catastrophe. Some pilots live to tell the tale, but over the last 15 years with the deployment of aircraft capable of rapid-onset high sustained +Gz there have been an increasing number of fatal fighter jet accidents which have been attributed to G-LOC. Recognition of unheralded G-LOC with rapid onset/high sustained G as a cause of aircraft accidents has led to G-training programs in many NATO Air Forces which have been successful in reducing but not eliminating the occurrence of G-LOC accidents. Whether or not a pilot recovers from a G-LOC episode in time to effect a recovery depends on a number of factors; situational including aircraft altitude and attitude when G-LOC occurs, and physiologic - the duration of G-LOC and time to recovery of neural function sufficient to allow recovery of control or ejection. The time to functional recovery following G-LOC has been studied by a number of investigators. Forster and Cammarota found centrifuge subjects who experienced GLOC had incapacitation times averaging about 12 seconds, from G-LOC to recovery sufficient to deactivate warning signals in the centrifuge. Recovery time for more complex behaviour including simulated trimming of aircraft power and acquisition of a target was longer, about 60 seconds. In a later study, Forster, Cammarota and Whinnery found incapacitation times of 15-20 seconds in aircrew participating in a G-training program who experienced G-LOC. Incapacitation times varied somewhat depending on the type of G-exposure (gradual onset or rapid onset). It was found that performance as measured by choice reaction times and anthmetic computation tasks was degraded during the first minute of recovery from G-LOC and progressively improved over the next 2-3 minutes. Although these studies provide information on the time to recovery of consciousness, there have been no studies which have monitored the ability of subjects to integrate the complex behaviour required to fly an aircraft following G-LOC. At DCIEM, Michel Paul has undertaken a study to measure subjects' ability to fly an aircraft simulator through a standard approach and landing immediately following an episode of G-LOC.
Derived from text
Seizures; Aerospace Medicine; Acceleration Stresses (Physiology); Consciousness; Physiological Effects; Unconsciousness; Aircraft Accidents

19960053799 Pennsylvania Univ., Dept. of Bioengineering, Philadelphia, PA United States
CERVICAL SPINAL CORD INJURY TOLERANCE UNDER +GZ ACCELERATION
Mazuchowski, E. L., II, Pennsylvania Univ., USA; Whitley, P. E., Hahnemann Medical Coll. and Hospital, USA; Thibault, L. E., Hahnemann Medical Coll. and Hospital, USA; Apr. 1996; 6p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Experimental manikin ejection data from the U. S. Naval Air Warfare Center was analyzed using a multimodality biomechanical approach to investigate the consequences that helmet mounted devices and improper head positioning have on the cervical spinal cord during ejection from high performance aircraft. Accelerations of the head center of gravity from the manikin studies were compared to a physical model of the head-neck complex run under similar conditions. Strain and strain rates in the cervical spinal cord obtained from this biofidelic physical model were compared to the functional tolerances of isolated myelinated axons, crustacean spinal cords, and isolated neurons. If the strain and strain rate exceed the isolated tissue and cell culture critical threshold levels (greater than 15% and 1s(exp -l), respectively), altered calcium homeostasis and electrophysiological dysfunction occur. Results suggest that moving the combined head-helmet center of gravity forward and positioning of the head improperly during ejection increase the possibility of neurological deficit and that the cervical spinal cord must be considered in evaluating the feasibility of egress procedures.
Derived from text
Spinal Cord; Biodynamics; Electrophysiology; Neurology; Strain Rate; Tissues (Biology); Acceleration Stresses (Physiology); Acceleration Tolerance

19960053800 Armstrong Lab., Neuropsychiatry Branch, Brooks AFB, TX United States
THE USE OF FINITE ELEMENT MODELING TO EVALUATE DISEASED SPINAL COLUMNS FOR AIRCRAFT EJECTION SAFETY
Drew, William E., Armstrong Lab., USA; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

A great deal of work has been accomplished analyzing ejection seat acceleration profiles and their effects on normal, non-diseased spinal columns in aviators. Considerably less work has been accom-

plished on the effects of aircraft ejection on diseased spines, which are, in fact, quite common in the flying community. This study was an attempt to address this concern and specifically to evaluate a particular mathematical model for accuracy in predicting whether specific spinal diseases or geometries will enable safe aircraft ejection without further spinal injury. Pilots ejecting from early aircraft ejection-seat systems had approximately a 12% incidence of vertebral fractures. The newer ejection systems have a lower maximum acceleration force in the Gz+ direction and also a considerably slower G onset and are generally safe for the typical pilot (adult male) without spinal disease when the pilot ejects within the envelope (altitude, speed and attitude limitations). But if a surgical procedure is done on the spine, e.g., a laminectomy, hemilaminectomy or cervical fusion, there may be a decrease in the overall strength of the spinal column, leading to a fracture or dislocation of vertebrae, disk herniation, or even spinal cord injury during ejection . Extensive previous work, including animal modeling and mathematical modeling, much of which has been performed by the Crew Systems Directorate at WrightPatterson AFB, addresses this issue for the nondiseased spine. When a pilot ejects from an aircraft in a typical ejection seat, his vertebral longitudinal axis is approximately in line with the rails on the back of the seat, which is the direction of thrust (Figure 1). Therefore, the direction of forces is essentially in line with the vertebral axis. Also, because the adult spine has a kyphotic and lordotic curvature, there are force vectors other than perpendicular in relation to the vertebrae.
Derived from text
Spinal Cord; Finite Element Method; Back Injuries; Diseases; Ejection Seats; Injuries; Vertebrae

19960053801 Royal Norwegian Air Force, Inst. of Aviation Medicine, Oslo, Norway
HYPOXIA INDUCED IMPAIRMENT OF GRANULOCYTE FUNCTION
Neslein, I. L., Royal Norwegian Air Force, Norway; Myhre, K., Royal Norwegian Air Force, Norway; Bjerknes, R., Royal Norwegian Air Force, Norway; Apr. 1996; 10p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Adequate resistance to infections depend upon, among other factors, the phagocytic capacity of polymorphonuclear neutrophilic granulocytes (PMNL). It is well documented that hypoxia stimulates the formation of red blood cells. But this study, together with some early works, indicate that hypoxia might stimulate the hematopoietic system in general, not only the eythropoietic cell lines. Hypoxia may interfere with ATP-dependent cell function. Intermittent or chronic exposure to hypoxia could therefore adversely affect resistance to infections. Rats were exposed to repeated hypobaric hypoxia (0,5 atm) for 17 hours per day for 0-7 days. This induced a significant reduction of the phagocytic capacity of the neutrophil granulocytes in addition to an increase in hematocrit, haemoglobin, thrombocyte, and total leukocyte concentrations. Differential counting of peripheral blood cells revealed significant granulocytosis, whereas the fraction of circulating lymphocytes was decreased. Microscopic examination and cell cycle analyses of rat bone marrow revealed stimulated hematopoiesis. An increase in the plasma concentration of corticosterone was observed in the middle of the experimental period, but was similar in the two groups by the end of the period. The reduced PMNL phagocytic capacity observed following repeated hypobaric hypoxia may have consequences for host defence in situations of exposure to hypoxia.
Author
Hypoxia; Leukocytes; Thrombocytes; Bone Marrow; Adenosine Triphosphate; Hematopoietic System; Hematopoiesis

19960053802 Ottawa Univ., Ottawa Civic Hospital, Ontario Canada
AUTOMATIC DETECTION OF CEREBRAL HYPOXIA USING FREQUENCY DOMAIN MAPPING AND NEURAL NETWORKS
Skinner, C. R., Ottawa Univ., Canada; Gray, Gary, Defence and Civil Inst. of Environmental Medicine, Canada; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

The development of quantified EEG (qEEG) in the form of frequency domain mapping has provided methods of automated analysis to detect normal and abnormal physiological states as well as definite neuropathological states in the brain. There is considerable importance in the various high risk military occupational environments to be able to detect incipient cerebral hypoxia. in order to prevent incapacitation due to hypoxia in real time This paper presents the current data which have been gathered and analysed at DCEM, NDMC and the Ottawa Civic Hospital in the development of automated models of detecting cerebral hypoxia using frequency domain analysis of EEG The basic method of analysis of spectral shifts of frequency domain spectra in epochs of 4 seconds of time. The results obtained show the spectral changes in normal wakeful individuals, normal individuals undergoing hyperventilation and volunteers subjected to levels of graded hypoxia The results from forty eight subjects of average age of 22 years performing hyper-ventilation as part of clinical EEG showed a large spectra shift in keeping with the slowing seen on time domain EEG The results of three subjects exposed to three levels of oxygen saturation showed at 80% saturation an initial decreased peak frequency with increase in amplitude At 70% saturation, there was a decrease in amplitude with a flattening and widening of the spectral pattern.
Author
Cerebrum; Hypoxia; Brain; Electroencephalography; Wakefulness; Physiological Effects; Oxygen; Neural Nets; Detection

19960053803 Institute of Aviation Medicine, Prague, Czechoslovakia
HEAD INJURIES IN MILITARY PILOTS
Konrad, Z., Institute of Aviation Medicine, Czechoslovakia; Dosel, P., Institute of Aviation Medicine, Czechoslovakia; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

The pilotage of modern military aircraft is highly specific activity which requires a perfect efficiency of the CNS including the coordination between the cortex, subcortical centers and separate effectors. The work of a pilot in the cockpit of current aircraft, typical with a lack of space, large number of controllers and instruments is connected with the necessity of immediate reactions during the information, gravitational and emotional overloads, thus making the demands on pilot's CNS functions enormous. The aim of flight surgeons, assessing the flying ability of the pilots is to admit only the individuals in perfect health condition. The head injury is undoubtedly a serious harm to the delicate brain functions. We should like to share with this competent forum the experience, obtained by the neurological department of the Institut of Aviation Medicine, Prague with the aeromedical assessment of these events in Czech, formerly Czechoslovak Air Force flying personnel during a period 1987 - 1994.
Derived from text
Aerospace Medicine; Brain; Central Nervous System; Neurology; Injuries; Head (Anatomy); Flying Personnel

19960053804 Naval Aerospace Medical Inst., Pensacola, FL United States
COGSCREEN-AEROMEDICAL EDITION IN THE ASSESSMENT OF THE HEAD INJURED MILITARY AVIATOR
Moore, J. L., Naval Aerospace Medical Inst., USA; Kay, G. G., Naval Aerospace Medical Inst., USA; Apr. 1996; 6p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

CogScreen-Aeromedical Edition (CogScreen-AE) is a computer administered and scored cognitive screening instrument designed to rapidly assess deficits or changes in attention, immediate and short-term memory, spatial-perceptual functions, calculation skills, reaction time, simultaneous information processing, and executive functions. The test was designed to detect subtle changes in cognitive functioning, which left un-noticed may result in poor pilot judgment or slow reaction time in critical operational situations. Normative data have been collected on over 800 commercial airline pilots and an equal number of military aviators. This paper will focus on applications of CogScreen-AE in the evaluation of head injured military aviation personnel. The CogScreen test results from a group of 24 mild to severely injured military aviators who were tested up to 90 months following head injury, and five of whom received serial evaluations, are presented. The results of the serial evaluations of five head injured military aviators are also discussed. Results demonstrate the sensitivity of the test to initial injury severity and recovery of function. The combination of conventional neuropsychological instruments and CogScreen-AE may expedite the return of head injured aviators to flying duties and actual control of aircraft.
Derived from text
Aerospace Medicine; Aircraft Pilots; Injuries; Head (Anatomy)

19960053805 German Air Force, Medical Academy, Munich, Germany
CARBOHYDRATE DEFICIENT TRANSFERRIN: A NEW MARKER TO EVALUATE ALCOHOL CONSUMPTION IN PILOTS
Freund, Wolfgang, German Air Force, Germany; Apr. 1996; 8p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

To test the possible value of new, comercially available test kits for Carbohydrate Deficient Transferrin (CDT) in an aeromedical setting, a clinical trial followed by an alcohol consumption trial have been conducted at the German Air Force Institute of Aviation Medicine (GAF IAM). The clinical trial with 268 tests showed that CDT is a valuable and accurate new tool in the assessment of alcohol consumption in otherwise healthy persons. The alcohol consumption trial showed that tests for CDT can not detect the difference between abstinency and consumption of 25ml of alcohol / day for three weeks. However, CDTect seems to be more stable than % CDT.
Derived from text
Aerospace Medicine; Alcohols; Carbohydrates; Markers; Detection

19960053807 Army Aeromedical Research Lab., Fort Rucker, AL United States
EXTENDING THE RANGE OF VISION TESTING: THE SMALL LETTER CONTRAST TEST
Rabin, Jeff C., Army Aeromedical Research Lab., USA; Apr. 1996; 8p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Recent evidence suggests that small letter contrast sensitivity (CS) is more sensitive than visual acuity (VA) to defocus, luminance, binocular enhancement, and visual differences among pilot trainees. It would be valuable to make this test available for general use. We developed a hard copy (letter chart) version called the Small Letter Contrast Test (SLCT) and evaluated its sensitivity and reliability in comparison to standard vision tests. The SLCT has 14 lines of letters with 10 letters per line. The letters are of constant size (20/25 at 4m), but vary in contrast by line in 0.1 log steps (0.01 log units per letter). Normal room illumination is used. The SLCT was evaluated in 16 subjects under various conditions (spherical and astigmatic blur, low luminance, two eyes vs. one) to determine test sensitivity and reliability, and in patients with clinical conditions. Scores were compared to those obtained with standard tests of VA (Bailey-Lovie) and CS (Pelli-Robson). SLCT scores were similar to previous measures, and retest reliability was one line. The SLCT was more sensitive than VA to spherical and astigmatic blur, low luminance, and vision with two eyes vs. one. Greater sensitivity of the SLCT endured despite correction for variability. The SLCT also was more sensitive than standard tests to visual loss from early cataract, keratoconus, corneal infiltrates, edema, and amblyopia. The SLCT is a powerful approach for revealing subtle visual loss which may be undetected by standard clinical techniques. The SLCT will prove useful for monitoring vision in refractive surgery, cataract, corneal and macular edema, optic neuritis, and for evaluation of candidates for unique occupations like aviation.
Derived from text
Visual Acuity; Visual Perception; Surgery; Patients; Luminance

19960053808 Armstrong Lab., Ophthalmology Branch, Brooks AFB, TX United States
OPTIC NERVE HEAD DRUSEN: AN EXAMPLE OF AEROMEDICAL DECISIONS REGARDING VISUAL FIELD LOSS
Burroughs, John R., Armstrong Lab., USA; Ivan, Douglas J., Armstrong Lab., USA; Thomas, Robert A., Armstrong Lab., USA; Tredici, Thomas J., Armstrong Lab., USA; Gooch, John M., Armstrong Lab., USA; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Peripheral vision is a vital function which serves to alert the aviator to a potential target that may deserve closer attention. The confrontation technique for visual field testing is an invaluable tool for use by the flight surgeon to screen for defects without the need for bulky equipment. Yet this technique may miss field defects of potential aeromedical significance. Optic nerve drusen are known to cause progressive visual field disturbances. Formal visual field testing is necessary in order to properly evaluate an aviator with a condition such as optic nerve drusen. We reviewed our experience with 18 aviators at the Aerospace Consultation Service who received the diagnosis of drusen of the optic nerve. The influence of drusen on visual function and on the aeromedical waiver recommendation process is discussed in order to provide insight regarding appropriate aeromedical management.
Derived from text
Aerospace Medicine; Peripheral Vision; Visual Fields; Aircraft Pilots

19960053809 Armstrong Lab., Ophthalmology Branch, Brooks AFB, TX United States
TRANSIENT VISION LOSS IN AIRCREW
Burroughs, John R., Armstrong Lab., USA; Ivan, Douglas J., Armstrong Lab., USA; Tredici, Thomas J., Armstrong Lab., USA; Perez-Becerra, Jose, Armstrong Lab., USA; Apr. 1996; 14p; In English; See also 19960053795; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Etiologic factors that can result in transient disruptions in vision comprise an extensive differential diagnosis and include both central nervous system and systemic causes. Aircrew are not immune to the majority of these etiologies and their vulnerability expands as they extend their flying careers. Furthermore, the aviation environment may introduce additional pre-disposing factors. This paper concentrates on those etiologies that are felt to be the most common or unique clinical entities potentially responsible for transient visual changes in aircrew and highlights specialized cases that relate directly to the aerospace environment, such as altitude-related phenomena. Management and disposition of aircrew with these problems often times presents a unique occupational dilemma. When applicable, the USAF ACS's experience with specific diagnoses related to transient visual loss or transient visual disturbances in aircrew is discussed.
Derived from text
Aerospace Environments; Flight Crews; Etiology; Central Nervous System

19960053811 Hellenic Air Force General Hospital, Otorhinolaryngology Dept., Athens, Greece
LIMITATIONS OF CNS FUNCTION IMPOSED BY VIBRATION IN FLIGHT
Diamantopoulos, Ioannis I., Hellenic Air Force General Hospital, Greece; Kechagiadakis, Eleutherios, Hellenic Air Force General Hospital, Greece; Apr. 1996; 12p; In English; See also 19960053795; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Vibration constitudes any form of motion that repeatedly alternates in direction.It is usually perceived by the senses as a series of sustained, mechanical, oscillatory disturbance. In everyday life as well as in aviation, vibrational energy reaches the body directly, by means of contact with a vibrating surface, or indirectly, by transmission through intervening bodies such as solids or fluids. When transmitted through air and bears characteristics in the audible range is treated as noise.
Derived from text
Central Nervous System; Sensory Perception; Vibration

19960053815 Centro de Instruccion de Medicina Aeroespatial, Hospital del Aire, Madrid, Spain
EFFECTS OF STRESS ON THE IMMUNOCELLULAR SYSTEM IN MILITARY PILOTS
MedialdeaCruz, J., Centro de Instruccion de Medicina Aeroespatial, Spain; LagunaMartinez, R., Centro de Instruccion de Medicina Aeroespatial, Spain; MartinDelMoral, M., Centro de Instruccion de Medicina Aeroespatial, Spain; MartinezHernandez, D., Centro de Instruccion de Medicina Aeroespatial, Spain; RiosTejada, F., Centro de Instruccion de Medicina Aeroespatial, Spain; Apr. 1996; 18p; In English; See also 19960053795; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

In studies on the CNS and the Immune System,both with a great capacity to receive and respond to any kind of stimulation -exterior as well as interior- it has only recently been considered that both are not completely autonomous,but that the interrelationship is more and more complex as investigations reveal new facts. According to ADER(1,23),all homeostatic defense organic systems are subject in a greater or lesser degree to the influence of environmental circumstances and psycological factors,whose integration evokes an adaptative response which,at the last moment,is regulated by the brain and whose consequences on health are not very well known at present.
Derived from text
Central Nervous System; Stimulation; Brain

19960053822 Army Medical Center, Dept. of Orthopaedics, Lackland AFB, TX United States
USE OF PSYCHOSTIMULANTS IN EXTENDED FLIGHT OPERATIONS: A DESERT SHIELD EXPERIMENT
Cornum, Kory, Army Medical Center, USA; Cornum, Rhonda, Army Medical Center, USA; Storm, William, Army Medical Center, USA; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

The present study examined the use of dextroamphetamine by F-I5C fighter pilots during Operation Desert Shield, the five month build up after arrival in Saudi Arabia but before Desert Storm (Persian Gulf War). These pilots were tasked with providing a continuous defensive and deterrent position in front of vulnerable high value assets, and were flown as Combat Air Patrol (CAP) missions. Airborne Warning and Control Squadron (AWACS) jets flew 24 hours a day to monitor Iraqi air activity, and F-15C aircraft flew missions to protect the AWACS and Saudi Arabia from a surprise attack. The missions were typically 4-6 hours in length and were scheduled well in advance. Additionally there were plenty of aircraft and pilots available to fly these missions. Thus, the pilots were well rested before all of these flights.
Derived from text
F-15 Aircraft; Flight Operations; Patrols; Aircraft Pilots

19960053823 Army Aeromedical Research Lab., Fort Rucker, AL United States
SUSTAINING HELICOPTER PILOT ALERTNESS WITH DEXEDRINE (R) DURING SUSTAINED OPERATIONS
Caldwell, John A., Jr., Army Aeromedical Research Lab., USA; Caldwell, J. Lynn, Army Aeromedical Research Lab., USA; Crowley, John S., Army Aeromedical Research Lab., USA; Apr. 1996; 12p; In English; See also 19960053795; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

.Sustained operations are a tactical necessity on the modem battlefield. However, the strain on personnel from sleep deprivation and fatigue remains problematic. Effective crew work/rest policies may prevent sleep loss and subsequent performance decrements in some situations, but stimulant medications may be the only alternative for sustaining performance in unpredictable combat operations. The present study investigated the efficacy of using dextroamphetamine as a countermeasure to sleep loss during sustained operations. Twelve subjects (6 males and 6 females) were exposed to two, 40-hour periods of contmuous wakefulness during which they flew a helicopter simulator and completed electroencephalographic (EEG) and mood evaluations. During the final 23 hours of one period, subjects were administered 3 separate I 0-mg doses of Dexedriner (at 0000, 0400, and 0800), and during the final hours of the other period, subjects were administered placebo. Test sessions occurred at 0100, 0500, 0900, 1300, and 1700 on both days. Results showed that flight performance was better under Dexedrine than placebo on 7 out of 9 sets of maneuvers. The benefits from Dexedrinet) were particularly apparent during the 0500 and 0900 flights when the combination of fatigue and circadian effects were most severe. Both EEG and mood evaluations were consistent with the performance effects in that Dexedrinet) was found to reduce slow-wave brain activity (associated with fatigue) and improve subjectve ratings of vigor, fatigue, and mental abilities. These data indicate that Dexedrine(R) is a viable countermeasure for sustaining the performance of both male and female pilots when operational demands prevent adequate, restorative sleep.
Derived from text
Helicopters; Sleep Deprivation; Stimulants; Wakefulness; Alertness; Circadian Rhythms; Males; Mental Performance; Moods

19960053824 Defence and Civil Inst. of Environmental Medicine, North York, Ontario Canada
THE EFFECT OF MODAFINIL AND AMPHETAMINE ON CORE TEMPERATURE AND COGNITIVE PERFORMANCE USING COMPLEX DEMODULATION DURING 64 HOURS OF SUSTAINED WORK
Pigeau, Ross, Defence and Civil Inst. of Environmental Medicine, Canada; Naitoh, Paul, Applied Psychophysiology Group, USA; Apr. 1996; 12p; In English; See also 19960053795; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Modafinil (diphenylmethyl-sulfinyl-2 acetarnide) is an alerting substance that is considered safer than amphetamine with fewer side effects. It appears to produce no feelings of euphoria, does not seem to be addicting, induces no drug tolerance and in large dosages (greater than 4500 mg) does not produce serious medical problems. These features make modafinil a good candidate to reduce or ameliorate the effects of prolonged sleep loss in military operations. The validity of these claims, however, is in question due to the very few number of controlled studies using normal adult subjects. Modafinil has been used primarily in either clinical studies to treat sleeping disorders or in animal studies to investigate its pharmacological properties. Modafinil is described as an alpha-1 adrenergic agonist, but Mignot et al. have recently questioned this interpretation, reporting that modafinil had good selectivity for the dopaminergic transporter. Nevertheless, the relatively benign psycho-pharmacological properties of modafinil make it a good candidate to reduce or ameliorate the cognitive effects of prolonged sleep loss under continuous workload conditions. Presently, use of modafinil in Canada is limited to scientific and/or clinical investigations.
Derived from text
Sympathetic Nervous System; Pharmacology; Neurophysiology; Military Operations; Mental Performance; Drugs; Dosage; Amphetamines

19970012397 Army of the Czech Republic, Expert Lab of the Inspector of the Air Force and Air Defence, Prague, Czechoslovakia
SINGLE BEAT LATE POTENTIALS AND THE RISK OF HUMAN FACTOR FAILURE DUE TO THE SUDDEN CARDIAC DEATH
Drska, Z., Army of the Czech Republic, Czechoslovakia; Polankova, M., Army of the Czech Republic, Czechoslovakia; Selection and Training Advances in Aviation; Nov. 1996; 4p; In English; See also 19970012387
Contract(s)/Grant(s): ACR-406/95/0737; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Especially due to the catecholamines compartment of stress managing, the microfocal dispersed changes of the myocardium are observed, the result of which is the myocardial electrical instability. In clinic these changes are known as predisposition to the life-threatening arrhythmias and/or to the sudden cardiac death. Late potentials (LP) are considered the manifestation of myocardial electrical instability in the body surface potential distribution within the electrical field of the heart. Standard procedure of late potential extraction is based on signal averaging of 3 ECG's from 200 to 400 electrical systoles, i.e., in the interval of two to six minutes. Discussed limitations are suppressed by developed procedure of LP extraction from single electrical systole. Input data is the matrix of eighty simultaneously measured ECG's and three vectorcardiographic ECG's from single systole. Singular Value Decomposition allows the noise suppression by exclusion of higher order (i.e., over the twentieth) orthogonal components from final signal reconstruction. From the mentioned the hypothesis of the relationship between coping with influence of psychosocial stressors and LP origination was adopted. Data from 48 healthy subjects (mean age = 42.68 years, SD = 14.65) and 29 subjects (mean age = 49.14 years, SD = 19.15) with sustained ventricular tachycardia proved by programmed ventricular electrical stimulation were analyzed. Using the logistic regression 81.82% (81.25% of healthy and 82.76% of subjects with sustained ventricular tachycardia) were correctly classified. Thus, single beat LP extraction appears to be a suitable compartment of methods for the early diagnostic of health risks of influence of psychosocial stressors especially within the subjects with high level of importance of possible risk of human factor failure (as pilots and/or air-traffic controllers).
Author
Cardiac Output; Failure; Arrhythmia; Tachycardia; Risk; Heart

19970012398 Royal Danish Air Force, Vojens, Denmark
ANAEROBIC CAPACITY AND HEIGHT RELATIONSHIP TO SIMULATED AIR COMBAT MANEUVER (SACM) - DURATION
Lenler-Eriksen, O., Royal Danish Air Force, Denmark; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A method to measure a pilots anaerobic capacity, correlated for height transfer this to an arbitrary measure for 'G duration tolerance' (GDT) is described. Results from 10 subjects form The Armstrong Laboratory, shows a significant correlation between GDT and SACM duration (P = 0.03). The method could be an inexpensive tool to get a picture af pilots SACM duration tolerance.
Author
Training Simulators; Combat

19970012410 Centre d'Essais en Vol, Laboratoire de Medecine Aerospatiale, Bretigny-sur-Orge, France
TRAINING OF TEST PILOTS: TO VENTILATE HIGH PRESSURE UNDER A LOAD FACTOR *ENTRAINEMENT DES PILOTES D'ESSAIS A LA SUPRESSION VENTILATOIRE SOUS FACTEUR DE CHARGE*
Ossard, G., Centre d'Essais en Vol, France; Clere, J. M., Centre d'Essais en Vol, France; Kerguelen, M., Centre d'Essais en Vol, France; Selection and Training Advances in Aviation; Nov. 1996; 6p; In French; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Anti-G protection by means of ventilator high pressure is currently being evaluated within the Rafale test program. Before use of this means of protection in actual flight, training of pilots in a centrifuge unit is recommended. This training has the goal to demonstrate to the pilots the tolerance improvement that can be achieved by means of positive pressure ventilation and sensitizing them to ergonomic and physiological particular features of this kind of anti-G protection. It is also intended to verify nominal functioning of pilot personal protection devices. Eighteen test pilots were subjected to three acceleration profiles. For the first profile they did not have any anti-G equipment. For the following profiles they wore an anti-G suit, either alone (second profile) or combined with ventilator high pressure device (third profile).
Author
Pilot Training; Ventilation; Test Pilots; Pressure Distribution; Loads (Forces); High Pressure; Centrifuges; Antigravity

19970015638 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
ECHOCARDIOGRAPHY IN NATO AIRCREW: A MULTI-NATIONAL STUDY *L'ENCHOCARDIOGRAPHIE CHEZ LES PILOTES DE L'OTAN- UNE ETUDE MULTINATIONALE*
Apr. 1997; 104p; In English
Report No.(s): AGARD-AR-351; ISBN 92-836-1052-0; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

Based on physiologic considerations and observations in animal experiments, a serious concern was raised: that repeated exposures to increased radial acceleration forces (+Gz) might have a deleterious effect on the pilot's heart. This concern was supported by the results of a preliminary echocardiographic (heart ultrasound) study carried out by French researchers and reported to AGARD in 1985. There were a number of uncontrolled variables in that initial study, including the amount of exercise and smoking. The investigators cautioned against forming any definite conclusion and recommended further studies. Because of these potentially serious occupational concerns and the findings of the preliminary study, the AGARD Aerospace Medical Panel initiated a carefully controlled study using echocardiography to compare current NATO pilots flying high-sustained G (HSG) aircraft with a control group of transport and rotary wing pilots. HSG aircraft were arbitrarily defined as those designed to maintain greater than +7Gz for at least 15 seconds, e.g. F-15, F-16, F-18, Mirage 2000, Hawk. Working Group 13 designed a protocol by which investigators from many NATO countries could contribute data to a central database. The study was carried out by Working Group 18 and involved over 30 investigators from 13 NATO countries. Data were collected and transmitted for analysis and quality control to a central database at the USAF Armstrong Laboratory at Brooks Air Force Base, Texas. Over 1600 echocardiograms were entered into the database. Data analyses compared 289 pilots of high sustained G (HSG) aircraft with 254 control pilots. The results conclusively show that there is no effect of HSG flight on the heart. The conclusions are limited to the resolution of the technology employed (echocardiography) and to the flight envelopes utilized in the current generation of NATO HSG fighter aircraft. The study serves as a model by which other military occupational medical questions may be addressed quickly and efficiently by the AGARD Aerospace Medical Panel.
Author
Aerospace Medicine; Echocardiography; Fighter Aircraft; Heart; Pilots (Personnel); High Gravity Environments

19970026047 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
MEDICAL SCREENING OF SUBJECTS FOR ACCELERATION AND POSITIVE PRESSURE BREATHING *LA SURVEILLANCE MEDICALE DES SUJETS RELATIVE AUX ACCELERATIONS ET A LA SURPRESSION VENTILATOIRE*
Jul. 1997; 48p; In English
Report No.(s): AGARD-AR-352; ISBN 92-836-0045-2; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

The AGARD Aerospace Medical Panel sponsored a Workshop on the Medical Surveillance of Subjects for Acceleration Research. There remain unanswered questions about the possible long-term medical complications of repetitive exposure to G forces. The outcome of the Workshop includes a consensus protocol for medical screening of subjects for acceleration research, and a protocol for a database to track medical occurrences of NATO centrifuges.
Author
Aerospace Medicine; Pressure Breathing; Stress (Physiology); Acceleration Tolerance; Acceleration Stresses (Physiology); Physiological Effects

19970026391 Institut Franco-Allemand de Recherches, Saint-Louis, France
PASSIVE AND ACTIVE TECHNIQUES FOR HEARING PROTECTION
Dancer, A., Institut Franco-Allemand de Recherches, France; Buck, K., Institut Franco-Allemand de Recherches, France; Hamery, P., Institut Franco-Allemand de Recherches, France; Parmentier, G., Institut Franco-Allemand de Recherches, France; Jun. 1997; 10p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The present state of passive and active techniques for hearing protection in the military environment is reviewed. Solutions which allow to protect the ear while preserving the operational abilities of the personnel (detection, localization, communication...) are especially emphasized.
Author
Noise Reduction; Ear Protectors; Auditory Perception; Armed Forces; Hearing; Voice Communication

19970026399 Royal Norwegian Air Force, Inst. of Aviation Medicine, Oslo, Norway
EFFECTS OF ACTIVE NOISE REDUCTION ON NOISE LEVELS AT THE TYMPANIC MEMBRANE
Wagstaff, A. S., Royal Norwegian Air Force, Norway; Woxen, O. J., Royal Norwegian Air Force, Norway; Jun. 1997; 6p; In English; See also 19970026380; Sponsored in part by Norwegian Air Ambulance; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Active noise reduction (ANR) is an electronic system that works by continuous sampling of noise inside the earshell of the headset with a small microphone. This signal is inverted in phase through the headset speaker, thus reducing noise levels by destructive interference of the acoustic field. The system provides good low-frequency noise attenuation, but air crew differ in their subjective opinion of ANR. The present study is an attempt to provide an objective assessment of the effect of ANR on noise levels at the tympanic membrane. Seven subjects with normal ears were placed in an environment of recorded noise from a BO-105 helicopter. A microphone probe was inserted to within 5 mm of the tympanic membrane of each subjects right ear. Noise levels in the ear were measured without a headset and with two different ANR headsets. Measurements were performed with and without the ANR system on, and, with and without white noise through the headset communication system. The white noise was used to simulate aircraft communication noise. The two headsets tested had differing levels of passive and active attenuation. The ANR system produced a substantial low-frequency attenuation. However, noise levels in the mid frequencies increased somewhat when the ANR system was switched on. This effect was augmented when white noise in the communications system was introduced, particularly for one of the two headsets. Low-frequency noise attenuation of ANR systems is substantial, but an increased mid-and high frequency noise level caused by the ANR may affect both communication and overall noise

levels. Our data provide advice on what factors should be taken into account when ANR is evaluated for use in an aviation operational environment.
Author
Aircraft Communication; Noise Reduction; Active Control; Acoustics; Continuous Noise; Earphones; Flight Crews; White Noise; Ear Protectors

19970034933 Armstrong Lab., Wright-Patterson AFB, OH United States
BURN HAZARD IN AIRCRAFT FIRES
Knox, F. S., III, Armstrong Lab., USA; Billotte, Bill, Wright Lab., USA; Ringhand, Stacy, Wright Lab., USA; Sep. 1997; 10p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Anyone who has seen a burn patient knows that burns are very traumatic, even life threatening, and often require more medical care than any other trauma. Moreover, the physical trauma is just the start; in many cases it is followed by psychological trauma. The psychological trauma can last a lifetime, daily reinforced by the disfigurement which often accompanies severe burns. Burn trauma teams now recognize this and employ psychological specialists who start therapy right along with the medical/physical therapy. All this extensive care costs a great deal of money. For all concerned, the best course is to prevent fires through good design practice. For example, the US Army was able to cut the incidence of burn injuries in survivable crashes to nearly zero by equipping its helicopters with crashworthy fuel systems and having its aviators wear protective flight suits. Part of the justification for that retrofit program was based on the cost of treating burned aviators and training their replacements. The retrofit program turned out to be both the humanitarian and cost effective thing to do. Part of calculating the cost/benefit of proposed fire safety measures is to be able to assess burn hazard with some accuracy. For example, one protective device worn by today's military pilots is their fire retardant flight ensemble. Historically these uniforms were tested in several ways. First, basic simple flammability tests showed which fabrics might be good candidates. The next step was to assess burn protective capability of various fabrics and fabric constructions. This protective capability was assessed by passing ensembles through fuel fires in an outdoor fire pit or by testing fabrics using pigs as aviator surrogates or by using heat flux sensors to measure heat transmitted through the ensemble and then using math models to predict the burn damage. The purpose of this paper is to focus on the burn prediction model, BURNSIM, and discuss its application to the study of fire/thermal sources in aviation. The model was originally developed to replace the use of pigs in testing protective fabrics, but subsequently has been applied to other cases such as side-by-side ejection seats, live fire testing and aerothermal heating during high MACH escape. Each of these applications will be discussed after presenting the burn model in some detail.
Derived from text
Aircraft Safety; Burns (Injuries); Fires; Flame Retardants; Flammability; Mathematical Models; Safety Devices; Flight Clothing; Fire Prevention

19980003879 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
IMPACT HEAD INJURY: RESPONSES, MECHANISMS, TOLERANCE, TREATMENT AND COUNTERMEASURES *LES TRAUMATISMES CRANIENS CONSECUTIFS AUX IMPACTS: LES MECANISMES, LA TOLERANCE, LE TRAITEMENT ET LES CONTREMESURES*
Nov. 1997; 242p; In English; Impact Head Injury: Responses, Mechanisms, Tolerance, Treatment and Countermeasures, 7-9 Nov. 1996, Mescalero, NM, USA; See also 19980003880 through 19980003902 Report No.(s): AGARD-CP-597; ISBN 92-836-1062-8; Copyright Waived; Avail: CASI; A11, Hardcopy; A03, Microfiche

These proceedings include the Technical Evaluation Report, a Keynote Address, and 23 invited papers, of the Specialists' Meeting sponsored jointly by the AGARD Aerospace Medical Panel, the Stapp Car Crash Conference Advisory Committee and the Society of Automotive Engineers. Severe head injury resulting from vehicular accidents is a major concern to military and civilian health care workers. Significant advances have been made in the understanding of the causes of severe brain injury and in the factors, both direct and indirect, that contribute to the pathophysiological changes that follow from a severe head injury. Moreover, advances in design and the proper use of countermeasures can significantly reduce head injuries causing death. This Specialists' Meeting addressed the issues of severe head injury from the point of view of: (a) the dynamic response of the head during impacts; (b) brain injury mechanisms in diffuse axonal injury; (c) physical and computer models for assessing injury severity; (d) human tolerance and injury criteria; (e) head injury assessment and treatment; (f) epidemiology in head injury mishaps; (g) harmonization and enforcement of standards for protective head gear; (h) personal protective systems in aircraft; and (i) computer simulations for optimizing head impact protective designs. These proceedings will be of interest to military and civilian medical professionals, accident investigators, safety engineers and research scientists concerned with safety issues in vehicular crash protection. They will also benefit the research manager and scientist or flight surgeon requiring a state-of-the-art review of relevant research in the field of impact head protection.
Author
Conferences; Countermeasures; Crashes; Dynamic Response; Head (Anatomy); Human Tolerances; Crash Injuries; Brain Damage; Damage Assessment; Biodynamics; Impact Damage; Impact Resistance; Impact Tests; Physiological Effects

19980003880 Heidelberg Univ., Heidelberg, Germany
SOME OBSERVATIONS TO THE SKULL-BRAIN TRAUMA
Kallieris, Dimitrios, Heidelberg Univ., Germany; Rizzetti, Andreas, Heidelberg Univ., Germany; Mattern, Rainer, Heidelberg Univ., Germany; Impact Head Injury: Responses, Mechanisms, Tolerance, Treatment and Countermeasures; Nov. 1997; 4p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Skull-brain injuries are caused through impact against rigid or padded obstacles. Injury pattern and injury severity of skull-brain trauma from experimental head impacts and autopsy cases are reported. The experimental part includes 10 head impacts (frontal, lateral or occipital and rigid or padded) with cadavers at a velocity of 20 km/h. A pneumatic impactor with a movable mass of 23 kg was used, the impact surface was a disc with 150 mm of diameter. Accelerations at the top of the head and the epidural pressure at the contrecoup site were measured. According to the acceleration measurements at the top of the head c.g. amounts between 85 g (padded) and 500 g (rigid); the rotational acceleration of the head around the rotation axis varies between 4700 rad/sec(sup 2) (padded) and 19000 rad/sec(sup 2) (rigid). Furthermore, the epidural pressure is between -20 kPa and -46 kPa. The observed fracture pattern and the injury severity of the skull are well comparable between the experimental exposure and the head impact during a sudden fall on the road. Furthermore, the injury pattern of the brain is also comparable, however, not the injury severity; the haematoma is of higher intensity in the accident cases. The brain injuries of the experiments include contrecoup subarachnoidal haematomas; furthermore skin lacerations were observed. The results are critically discussed with those existing in the literature.
Author
Impact Damage; Impact Tests; Head (Anatomy); Human Tolerances

19980003881 Medical Coll. of Wisconsin, Dept. of Neurosurgery, Milwaukee, WI United States
IMPACT BIODYNAMICS OF HUMAN SKULL FRACTURE
Sances, Anthony, Jr., Medical Coll. of Wisconsin, USA; Yoganandan, Narayan, Medical Coll. of Wisconsin, USA; Pintar, Frank A., Medical Coll. of Wisconsin, USA; Kumaresan, Srirangam, Medical Coll. of Wisconsin, USA; Walsh, Patrick R., Medical Coll. of Wisconsin, USA; Nov. 1997; 6p; In English; See also 19980003879; Sponsored in part by George Snively Memorial Foundation
Contract(s)/Grant(s): DTNH22-93-Y-17028; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The purpose of the present study was to determine the force-deflection biomechanics of the human cadaveric intact head under quasistatic and dynamic loading. Both nonfracture and fracture studies were conducted under known boundary conditions to delineate the stiffness, energy, and force-deflection characteristics for future use in finite element investigations and helmet protection studies.
Author
Biodynamics; Head (Anatomy); Impact Tests; Human Tolerances; Impact Damage; Damage Assessment; Human Factors Engineering

19980003882 Duke Univ., Dept. of Biomedical Engineering, Durham, NC United States
BASILAR SKULL FRACTURE RESULTING FROM COMPRESSION NECK LOADING
Myers, Barry S., Duke Univ., USA; Richardson, William J., Duke Univ., USA; Nightingale, Roger W., Duke Univ., USA; Nov. 1997; 10p; In English; See also 19980003879; Sponsored in part by Virginia Flowers Baker Chair
Contract(s)/Grant(s): R49/CCR402396-10; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A cadaver head and neck impact model has been developed to produce a wide variety of clinically observed cervical spine injuries and basilar skull fractures. The impact model includes a drop track which allows impact of the head and neck with a simulated torso mass following into an obliquely oriented surface with varying amounts of surface padding. Twenty unembalmed ligamentous cadaver head-neck specimens have been dropped in an inverted posture with the head and neck in the anatomically neutral position. Multiaxis transduction recorded head impact forces, planar head accelerations, and neck reactions. In addition, the impact tests were imaged using a high speed imaging system at 1000 frames. The head-neck-torso response was bimodal, including a head inertial loading mode followed by a neck-impact surface loading mode. A total of three basilar skull fractures were produced among 16 specimens suffering injuries, one in an impact to a rigid surface, and two in impacts to padded surfaces. Additionally, each of these injuries occurred in the neck-impact loading mode and were therefore unrelated to peak head impact force, or head acceleration. These data suggest that these injuries may occur with greater frequency than previously thought. They also suggest that some basilar skull fractures occur mechanistically like neck injuries and are not likely to be mitigated with the addition of impact surface padding.
Author
Impact Tests; Skull; Impact Damage; Human Tolerances; Damage Assessment; Human Factors Engineering; Spine

19980003883 Pennsylvania Univ., Dept. of Bioengineering, Philadelphia, PA United States
THE ROLE OF KINETIC LOADING PARAMETERS ON THE SEVERITY OF DIFFUSE AXONAL INJURY IN CLOSED HEAD INJURY
Miller, R. T., Pennsylvania Univ., USA; Smith, D. H., Pennsylvania Univ., USA; Han, X., Pennsylvania Univ., USA; Xu, B., Pennsylvania Univ., USA; McIntosh, T. K., Pennsylvania Univ., USA; Meaney, D. F., Pennsylvania Univ., USA; Nov. 1997; 8p; In English; See also 19980003879; Sponsored in part by Ashton Fellowship
Contract(s)/Grant(s): R49/312712; NIH-NS-08803; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In this report, we describe relationships between the kinetic loading parameters and the incidence of axonal injury in an experimental model of diffuse axonal injury used in our laboratory. Twenty animals (Hanford miniature pig, 13-20 kg, 3-4 months old) were injured using a coronal plane rotational acceleration of the head. Both the magnitude of angular acceleration and change in angular velocity were varied in these tests over a controlled range (56-260 krad/s(sup 2); 174-472 rad/s). Seven days following injury, injured brains were examined using immunocytochemical markers for injury (NF200, SMI-3, and SMI-32) and maps of both the axonal injury distribution and severity were produced for selected coronal planes. Analysis of these injury maps revealed that the extent of injury in the mid-hippocampal plane was reasonably correlated to kinetic loading parameters (R=.66,.76), but that the correlations were less strong when focusing on specific intensities of axonal injury. Additionally, the severity of axonal injury in a given location, correlated to the loading parameters, but the changes were not statistically significant. Together, this study forms an important starting point for relating load parameters to injury within the brain, and can likely be improved with more advanced computational modeling capabilities.
Author
Axons; Brain Damage; Damage Assessment; Head (Anatomy); Impact Tests; Impact Damage

19980003884 Pennsylvania Univ., Dept. of Bioengineering, Philadelphia, PA United States
IN VIVO MECHANICAL THRESHOLDS FOR TRAUMATIC AXONAL DAMAGE
Bain, Allison C., Pennsylvania Univ., USA; Billiar, Kris L., Miami Univ., USA; Shreiber, David I., Pennsylvania Univ., USA; McIntosh, Tracy K., Pennsylvania Univ., USA; Meaney, David F., Pennsylvania Univ., USA; Nov. 1997; 12p; In English; See also 19980003879
Contract(s)/Grant(s): NIH-NS-08803; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A methodology to identify tissue level axonal stress and strain from macroscopic parameters is outlined. A non-linear, viscoelastic, structural relationship is proposed to describe the in vivo response of the guinea pig optic nerve to uniaxial elongation. The optic nerve is modeled as a bundle of parallely aligned axons undulated to varying degrees. When straightened, each axon displays non-linear, viscoelastic behavior that contributes to the overall behavior of the optic nerve. Optic nerves were examined microscopically to calculate the undulation of individual axons. Axonal undulation was found to follow a gamma distribution, with a mean undulation of 1.070 and a standard deviation of 0.053. A reduced relaxation function, consisting of two exponential terms, was approximated from in vivo, dynamic elongation of the guinea pig optic nerve. Results from the in vivo relaxation tests indicated that the relaxation behavior was independent of displacement, a requirement for linear, viscoelastic theory based on hereditary integrals. The instantaneous elastic function was expressed as an integral of the undulation distribution and a function of the stretch ratio. Initially, a linear stretch ratio function was assumed to analyze the effects of the undulation distribution on the instantaneous elastic response. These results were compared with those obtained by increasing the order of the stretch ratio function to a third order polynomial. The computed results of the proposed structural relationship compared well to the experimental data from in vivo optic nerve tests, indicating that this model could provide a framework for identifying axonal thresholds for traumatic injury.
Author
Axons; Nerves; Damage Assessment; Models; Brain Damage

19980003885 Chrysler Corp., Auburn Hills, MI United States
MODELING CAVITATION DURING HEAD IMPACT
Nusholtz, Guy, Chrysler Corp., USA; Glascoe, Lee G., Michigan Univ., USA; Wylie, E. Benjamin, Michigan Univ., USA; Nov. 1997; 12p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The effects of stress in brain material was investigated with experimental and computational idealizations of the head. A water-filled cylinder impacted by a free traveling mass serves to give insight into what could happen to the brain during impact; particularly the effect of the state of stress on possible physical changes in the brain material. When the cylinder is struck by a free-flying mass of sufficient velocity, cavitation is initiated at the boundary opposite impact. Significant vaporous regions may develop at the boundary, while only limited vaporization occurs internally. The vaporization that does occur internally consists of diffuse micro-voids. Higher accelerations, or an additional loading of the domain by a constant acceleration perpendicular to impact, adds to the likelihood and to the increased severity of internal cavitation, increasing the size, number and density of micro-voids. As a result, the micro-voids that form may not only produce injuries in the typically perceived cavitation damage response, i.e., violent cavity collapse, but also by producing local large strains as a result of cavity formation. In addition, when a local section of brain is significantly populated with micro-voids, the bulk and shear properties can change. Therefore, cavitation-caused cellular damage, including a non-violent collapse mechanism resulting from stress in the brain material might be more common than previously thought. Cavitation occurred in these experiments at accelerations greater than 150 g's.
Author
Impact Damage; Damage Assessment; Head (Anatomy); Brain Damage; Mathematical Models; Cavities

19980003886 Wayne State Univ., Bioengineering Center, Detroit, MI United States
HEAD INJURY ASSESSMENT OF A REAL WORLD CRASH BY FINITE ELEMENT MODELING
Zhou, Chun, Wayne State Univ., USA; Khalil, Twafik B., Wayne State Univ., USA; King, Albert I., Wayne State Univ., USA; Dragovic, Ljubisa

J., County of Oakland, USA; Nov. 1997; 8p; In English; See also 19980003879
Contract(s)/Grant(s): R94/CCR503534-07; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper demonstrates the potential of the WSU (Wayne State University) Brain Injury Model in predicting brain injuries sustained in a real motor vehicle crash. The particular case simulated here was a side impact in which the victim succumbed to multiple injuries, including a severe brain injury. The first step in the process was to use the EDSMAC code to obtain gross vehicular kinematics. The output of the EDSMAC run was used as input to a MADYMO simulation of the occupant kinematics and interaction with the vehicular structures of both the struck and striking vehicles. The computed head acceleration was then applied to the new three-dimensional finite element model of the head to determine the response of the brain to this crash loading. The injury severity was assessed by identifying areas of high shear strain and comparing them with autopsy data that showed locations of petechial hemorrhage where diffuse axonal injury (DAI) presumably occurred. The crash reconstruction revealed a possible head contact with the hood of the striking vehicle, even though no signs of contact were seen on the head at autopsy. The estimated resultant linear acceleration was about 220 g's. The estimated lateral angular acceleration was about 20,000 rad/s(sup 2). The estimated sagittal angular acceleration was about 11,000 rad/s(sup 2). Better estimation could have been made if more information were available. The shear strain distribution within the brain exhibited some degree of correspondence with the sites of DAI. It is very promising that the shear stress contours can be used to make predictions of DAI.
Author
Three Dimensional Models; Brain Damage; Human Tolerances; Impact Damage; Damage Assessment; Crash Injuries; Head (Anatomy)

19980003887 General Motors Corp., Safety Research Dept., Warren, MI United States
TISSUE LEVEL INJURY CRITERIA USING BRAIN FINITE ELEMENT ANALYSIS, BILATERAL IMPACT MODEL
Ueno, Kazunari, General Motors Corp., USA; Melvin, John W., General Motors Corp., USA; Nov. 1997; 16p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A finite element model of a cortical impact experiment following double craniotomy was built and exercised independently with three different finite element programs, i.e., Dyna3d, Pamcrash and Abaqus as a partial validation of the protocol in establishing tissue level injury criteria for the head/brain subjected to an impact load. A typical experimental impactor motion (4 mm displacement in 1.5 ms, 5 m/s initial velocity) was successfully simulated in all programs and the results were favorably compared to each other in terms of overall stress values, time histories and distributions. The peak Von-Mises stress (120 kPa) was observed in the depth of the brain while the pressure peak (160 kPa) was observed at the surface of the brain. Both pressure and Von-Mises stress wave propagations were in accord with the theoretical wave speeds. The explicit programs (Dyna3d and Pamcrash) have a 600 fold CPU advantage and a smoother stress response compared to the implicit program (Abaqus).
Author
Finite Element Method; Mathematical Models; Crash Injuries; Brain Damage; Head (Anatomy); Applications Programs (Computers)

19980003888 National Highway Traffic Safety Administration, Washington, DC United States
USE OF FINITE ELEMENT ANALYSIS AND DUMMY TEST MEASUREMENTS IN THE ASSESSMENT OF CRASH IMPACT TRAUMATIC BRAIN INJURY
Bandak, F. A., National Highway Traffic Safety Administration, USA; Tannous, R. E., George Washington Univ., USA; Eppinger, R. H., National Highway Traffic Safety Administration, USA; Toridis, T., George Washington Univ., USA; DiMasi, F., Federal Aviation Administration, USA; Zhang, A. X., Conrad Technologies, Inc., USA; Nov. 1997; 14p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Three computational models were used to interpret experimental data as a first step in developing a process to predict traumatic brain injury (TBI) potential in motor vehicle crashes. The process and the prevailing conditions limiting its current viability are discussed. The first model, a two dimensional model of the miniature pig brain, was gauged against existing experimental data using a previously introduced Cumulative Strain Damage Measure (CSDM). Results from this model were utilized in the analysis of output from two simple three dimensional models of the human brain one representing an adult and the other scaled in a crude attempt to simulate the six year old child brain. The miniature pig computer model was subjected to loads identical to those used in existing brain injury experiments. The human models were loaded using measured kinematic response data from actual crash dummy tests. The dummy test data was converted to model loadings using a previously reported method and a new experimental technique for measuring the spatio-temporal distribution of pressure resulting from head impact is also introduced. Twelve cases were analyzed using the two human finite element models. Six involved the Hybrid III dummy and six involved the six year child version of the dummy. The crash test results were evaluated on the basis of several proposed finite element based brain damage measures as well as the values of the Head Injury Criterion. Preliminary results indicate that the proposed procedure is feasible for the assessment of head injury potential pending the availability of material data and consistent load measurement processes.
Author
Brain Damage; Crash Injuries; Finite Element Method; Three Dimensional Models; Head (Anatomy); Impact Tests; Impact Damage; Damage Assessment

19980003889 General Motors Corp., Safety Center, Warren, MI United States
HEAD INJURY RISK ASSESSMENTS BASED ON 15 MS HIC AND PEAK HEAD ACCELERATION CRITERIA
Mertz, H. J., General Motors Corp., USA; Prasad, P., Ford Motor Co., USA; Nusholtz, G., Chrysler Corp., USA; Nov. 1997; 10p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A review is given of the development of the Head Injury Risk Curve (HIRC) which is based on 15 ms HIC, and the Skull Fracture Risk Curves (SFRC) which are based on the 15 ms HIC and the Peak Head Acceleration criteria respectively. Each of the risk curves was developed by analyzing the relevant cadaver head impact data using the Mertz/Weber Method which is a simplified form of the Median Rank technique. The Mertz/Weber Method was used to estimate the injury risk to the adult driving population because the test samples of cadavers were biased with specimens having poorer bone conditioning factors than the driving population. The Mertz/Weber Method is not affected by this type of bias since the form of the distribution curve is assumed apriori. The efficacy of the Head Injury Risk curve is demonstrated by noting that the predicted reduction in head injuries due to certification of American football helmets based on the HIRC was 78 percent compared to the actual reduction in head injury risk of 74 percent. The efficacy of the Skull Fracture Risk Curve based on 15 ms HIC is demonstrated using a finite element model of the head. There was no agreement between model results and the SFRC based on peak head acceleration since the time-dependency associated with bone failure is not addressed by the Peak Head Acceleration criterion. This limitation of the Peak Head Acceleration criterion is demonstrated by analyzing Transport Canada's 30 mph rigid barrier vehicle test results. Assuming a 5 percent risk of skull fracture as a design limit, then 20 tests would fail to meet this limit based on the 15 ms HIC criterion, but only 10 tests would fail based on the Peak Head Acceleration criterion. Further, it is noted that the proposed 80 G limit for Peak Head Acceleration is very design restrictive since it represents a 0.1 percent risk of skull fracture. The corresponing 15 ms HIC value for this level of skull fracture risk is 100.
Author
Head (Anatomy); Injuries; Risk

19980003890 Cambridge Univ., Cambridge, United Kingdom
COMPLEMENTARY ROLE OF FUNCTIONAL BRAIN IMAGING AND MULTI-MODALITY BEDSIDE MONITORING FOR ACUTE BRAIN INJURY: PATHOPHYSIOLOGY AND SURROGATE END POINTS
Pickard, John D., Cambridge Univ., UK; Kirkpatrick, Peter J., Cambridge Univ., UK; Czosnyka, Marek, Cambridge Univ., UK; Menon, David, Cambridge Univ., UK; Minhas, Parvan, Cambridge Univ., UK; Smielewski, Peter, Cambridge Univ., UK; Clark, John, Cambridge Univ., UK; Herrod, Nick, Cambridge Univ., UK; Carpenter, Adrian,

Cambridge Univ., UK; Downey, Stephen, Cambridge Univ., UK; Kendall, Iona, Cambridge Univ., UK; Nov. 1997; 4p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

This paper reviews the advances in management of non missile head injury over the past 30 years, and the factors known to affect outcome. It has proven difficult to exploit recent advances in the development of novel neuroprotective agents in patients with head injury and the reasons are explored together with the emerging role of multimodality bedside monitoring and functional brain imaging (Positron Emission Tomography and Magnetic Resonance) in defining more homogeneous sub-groups of patients for more focussed trials of such novel agents.

Author

Brain Damage; Imaging Techniques; Injuries; Damage Assessment; Head (Anatomy)

19980003891 Armstrong Lab., Neuropsychiatry Branch, Brooks AFB, TX United States

CLOSED HEAD INJURY AND THE MILITARY AVIATOR: ASSESSING COGNITIVE DYSFUNCTION AND SEIZURE RISK

Drew, William E., Armstrong Lab., USA; Patterson, John C., Armstrong Lab., USA; Nov. 1997; 4p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Over the last several years, two concerns have become evident with respect to the aeromedical disposition of aviators following closed head injuries. The first problem is that aviators, even with mild closed head injuries, often have subtle cognitive impairment. This impairment is often not apparent on clinical examination or cursory mental health evaluation such as the Folstein Mini-Mental State Examination. The second problem is the risk of post-traumatic seizures primarily in aviators with moderate or severe closed head injuries. Both of these conditions clearly are problematic for the flying population in terms of information processing and sudden incapacitation. As task saturation poses a problem for individuals with the highest levels of cognitive functioning and psychomotor skills, i.e., "Top Guns", any cognitive impairment, to include cognitive slowing, poses a risk for flying safety. Clearly, sudden incapacitation, such as those resulting from post-traumatic seizure are incompatible with flying safety as well. An important aspect of closed head injury in occupational and aerospace medicine is the classification. Based on this classification, a research program has been developed to further study head injury as it relates to aeromedical disposition.

Author

Aircraft Pilots; Head (Anatomy); Physiological Effects; Risk; Cognition; Crash Injuries; Damage Assessment; Seizures

19980003892 Wayne State Univ., School of Medicine, Detroit, MI United States

SECONDARY INJURY AFTER SEVERE TRAUMATIC BRAIN INJURY: MECHANISMS TOWARD WHICH CLINICAL TRIALS ARE TARGETED

Muizelaar, J. Paul, Wayne State Univ., USA; Nov. 1997; 4p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

In this paper, we cite literature showing that after traumatic brain injury (TBI) much of the damage is done well after the impact, even though the morphological appearance might suggest otherwise. The biochemical cascades leading to this secondary or delayed injury are demonstrated. Drugs are available to interfere with specific pathways or steps in these biochemical cascades. The general principals of clinical trials to test the safety and efficacy of these drugs are described: Double-blind, randomized, placebo-controlled design; Entry criteria, concerning the severity of the injury, mostly based on the Glasgow Coma Scale; Outcome measurement, mostly based on the Glasgow Outcome Scale. Specific drugs and the status of their clinical trials are also described: Oxygen radical scavengers and lipid peroxidase inhibitors have failed in large scale, phase III trials; NMDA receptor antagonists are currently in phase III trials. Different types of calcium channel blockers have been tested or are ready to enter into phase III trials. Some trials with drugs with different mechanisms or trials with new management strategies (hypothermia) are also mentioned.

Author

Biochemistry; Brain Damage; Injuries; Drugs

19980003893 Institute of Neurological Sciences, Glasgow, United Kingdom

HEAD PROTECTION: MOTOR CYCLISTS, SPORTS AND INDUSTRY

Doyle, D., Institute of Neurological Sciences, UK; Sturrock, K., Institute of Neurological Sciences, UK; Nov. 1997; 8p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Protection against brain injury has been the major concern of those who have been involved in the design of head wear for participants in dangerous pursuits. Various forms of head gear have been available throughout the ages for horsemen and those concerned with military pursuits. The development of engine driven vehicles and aircraft has led to empirically designed protective hats and helmets but, relatively recently, the scientific input into the design of helmets has become more noticeable. These have led to the creation of national and international standards for the design of helmets for various activities. One of the purposes of the studies, in which we have been involved, has been the evaluation of causes of brain injuries. Looking at these, with a view to brain protection, has led to a number of observations which seem relevant to the development of protective helmets. We have had the opportunity to study accidents and injuries in pedal cyclists, motor cyclists, horse riders, vehicle occupants, pilots and industrial workers, all of which groups have had helmets specifically designed for their use. An attempt is being made to provide information on mechanisms of brain injury in humans and to provide information on the value and performance of helmets.

Author

Brain Damage; Helmets; Protection; Crash Injuries; Head (Anatomy)

19980003896 Army Aeromedical Research Lab., Fort Rucker, AL United States

US ARMY AIRCREW HELMETS: HEAD INJURY MITIGATION TECHNOLOGY

McEntire, B. Joseph, Army Aeromedical Research Lab., USA; Nov. 1997; 10p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Head injury remains the predominant cause of severe and fatal injuries to Army aircrew involved in helicopter mishaps. As a means to prevent injuries or reduce their severity, the U.S. Army has continuously sought improvements to aviator helmets. Numerous improvements have resulted from analysis of helmets involved in aviation accidents and the wearer's injuries. It is believed that the newest Army aviator helmet, the HGU-56/P, offers significant improvements over earlier designs. This paper presents a chronology of Army aviator helmets with descriptions defining their differences and improvements.

Author

Helmets; Impact Resistance; Crash Injuries; Product Development; Head (Anatomy)

19980048994 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France

INJURY PREVENTION IN AIRCRAFT CRASHES: INVESTIGATIVE TECHNIQUES AND APPLICATIONS *LA PREVENTION DES LESIONS LOR DES ACCIDENTS D'AVIONS: LES TECHNIQUES D'INVESTIGATION ET LEURS APPLICATIONS*

Feb. 1998; 100p; In English, 24-25 Nov. 1997, Farnborough, Madrid, UK, Spain; See also 19980048995 through 19980049001

Report No.(s): AGARD-LS-208; ISBN 92-836-1068-7; Copyright Waived; Avail: CASI; A05, Hardcopy; A02, Microfiche

This Lecture Series addresses a critical aspect of the investigations related to the factors implied in the prevention of potential injuries among aircraft occupants as a consequence of impact and post-crash fires, heat and toxic fumes. It comprises a review of the critical aspects of injury prevention. The topics covered included a description of the acceleration vectors involved, how they may have an influence on the aircraft, and how the acceleration forces might be tolerated by the aviator. In addition, the physical analysis of impact and crash survivability is discussed, focusing on what happens during a mishap. Furthermore a review is made on how to evaluate the tolerable deceleration forces and occupiable space required to sustain life. A part of this LS is devoted to answering questions such as, when did the injury occur, the nature of the forces that produced the injury, and their relationship to a mishap. Injury types related to the thermal and intrusive impact of the deceleration forces are also discussed, as are aspects

related to the collection of medical information that would help identify the potential causes and the effects of an individual; in particular, the way in which the occupant moves in response to the forces applied. These forces may have a profound effect upon the nature and severity of the injury. This Lecture Series, sponsored by the Aerospace Medicine Panel of AGARD, has been implemented by the Consultant and Exchange Program.
Author
Aircraft Accidents; Aircraft Accident Investigation; Crashworthiness; Design Analysis; Escape Systems; Injuries; Prevention; Human Tolerances

19980048996 Royal Air Force Inst. of Aviation Medicine, Accident Investigation, Farnborough, United Kingdom
HUMAN TOLERANCE TO ABRUPT ACCELERATION
Cugley, Jennifer, Royal Air Force Inst. of Aviation Medicine, UK; Injury Prevention in Aircraft Crashes: Investigative Techniques and Applications; Feb. 1998; 8p; In English; See also 19980048994; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Short duration accelerations resulting in injury or death can be inflicted not only on the occupants of vehicles involved in crashes, but also on pedestrians, sportsmen, persons falling from a height, and those exposed to explosions and bomb blast. The injury may be received when a person in motion comes into collision with a solid object or when an object or missile strikes a stationary person. Irrespective of the circumstances surrounding the accident, injury occurs when a person is exposed to forces of some magnitude for a brief period of time, and the degree of injury is related to the magnitude and duration of the applied forces. Hence, the study of accidental injury can be summarized as what we hit, how we hit it, how long we hit it for, how many times we hit it and which part of the body is subjected to the insult. For effective injury reduction programs to be introduced, an appreciation must be gained of the way in which accidents cause injuries, the nature of the forces contributing to the injuries and the characteristics of the type of accident under investigation.
Derived from text
Human Tolerances; Acceleration; Collisions; Injuries; Accident Investigation

19980048997 Biodynamic Research Corp., San Antonio, TX United States
PRINCIPLES OF CRASH SURVIVABILITY
Raddin, James H., Jr., Biodynamic Research Corp., USA; Feb. 1998; 8p; In English; See also 19980048994; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

A comprehensive review of the history of impact protection is clearly beyond the scope of the review. The interested reader is referred to the bibliography for the chapter on Biodynamics: Transitory acceleration in DeHart's Fundamentals of Aerospace Medicine. Suffice is to say here that the endeavor or protect occupants in aircraft crashes began with the pioneers of aviation and continues to the present day. It has met with considerable success but remains limited by the remarkable violence that can be wrought when fast moving objects meet fixed ones. The human body has a meager ability to cope with such violence without assistance and practical methods of assistance can only go so far. The basic line os attack on the problem have generally been to provide a container to surround the occupant, provide a seat and restraint to hold him there, limit the accelerations of the container to tolerable levels, provide personal protective equipment such as helmets, and control for post-crash factors such as fire or water landing. Ejection seats, capsules or modules were something of a special case, since they were intended to allow the occupant to avoid the crash altogether. However, they posed their own set of risks such as the ejection accelerations, windblast, altitude exposure, parachute opening shock, parachute landing, and a host of others. They made a real contribution in many cases, but they didn't make the problem of impact injury go away.
Derived from text
Aircraft Accidents; Constraints; Protection; Ejection Seats; Helmets; Human Body; Crashes; Survival

19980048998 Biodynamic Research Corp., San Antonio, TX United States
THE PHYSICAL BASIS OF IMPACT INJURY AND ITS PREVENTION
Raddin, James H., Jr., Biodynamic Research Corp., USA; Feb. 1998; 6p; In English; See also 19980048994; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Effective prevention of injury in aircraft crashes and the investigation into injury occurrence in those crashes requires a knowledge of how impact injury occurs and how protective techniques work. This review will examine the physical underpinnings of the art of impact protection as applied to vehicular impacts. The same principles apply to terrestrial vehicles, aircraft, and spacecraft in a wide range of impacts and other sudden accelerations. Because they happen so rapidly, they are sometimes difficult to understand in terms of our slower moving daily experience. Some of the understandings may even be counter-intuitive as a result of the need to observe the event from various frames of reference. The review must therefore begin with some basic physics and apply those principles to the collision event. Approaches to describing crash motions and crash severity will be outlined before describing how to analyze occupant motions in a crash. The physics of injury will be briefly reviewed and applied in defining injury mechanisms and injury criteria. Finally, general approaches to crash protection will be addressed along with some perspectives on how to analyze and assess the effectiveness of crash protection. Example cases will be presented with the oral presentation to illustrate the application of the principles reviewed in the paper.
Derived from text
Aircraft Accidents; Impact; Injuries; Prevention; Collisions

19980048999 Biodynamic Research Corp., San Antonio, TX United States
APPLICATIONS OF PHYSICAL ANALYSIS AND CRASH SURVIVABILITY
Banks, Robert D., Biodynamic Research Corp., USA; Feb. 1998; 4p; In English; See also 19980048994; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

An aircraft accident is always an emotional event that triggers a flurry of activity, particularly if fatalities are involved. Rescuers, damage control crews, search and rescue teams, MEDEVAC teams, and support staff each play a well rehearsed role in activities surrounding the event. Every accident is unique, with its own set of circumstances, surroundings, mysteries and dangers. Initial confusion is always present. But amidst the wreckage, log of events, communication tapes, eye witness accounts, mission briefing, technical manuals, personal interviews and pathology lie important clues that, properly organized and understood, will indicate the cause and the consequences of the accident. The questions confronting an accident investigation board can vary, but usually involve two issues. The first centers on the cause of the accident. Explaining the cause is fundamental to future prevention of similar accidents. The task of making 'sense' from 'nonsense' can be awesome. An investigating team is usually confronted with a confused abundance of physical and human evidence, and an organized approach to information collection and analysis is needed to succeed.
Derived from text
Accident Investigation; Aircraft Accidents; Rescue Operations; Emotional Factors; Damage; Prevention

19980049000 Armed Forces Inst. of Pathology, Washington, DC United States
AVIATION PATHOLOGY
Cogswell, Steven C., Armed Forces Inst. of Pathology, USA; Feb. 1998; 10p; In English; See also 19980048994; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Aircraft crashes are generally predictable in type and frequency. Different types of aircraft have different types of crashes. Similarly, occupant injuries follow generally predictable patterns, and themselves often consist of patterned abrasions and contusions reflecting portions of the aircraft structure. The role of the medical investigator and/or pathologist includes documentation and interpretation of these injuries to determine how the injuries occurred so that they may be minimized or prevented. The pathologist's documentation and interpretation of injuries, together with manifestations of natural disease processes, provides the core of the Human Factors data for analysis. As few pathologists are familiar with aircraft crash injuries, their interpretation of the injury patterns may be incorrect, which may significantly compromise the investigation.
Derived from text
Aircraft Accidents; Crash Injuries; Pathology; Human Factors Engineering; Aerospace Medicine; Crashes; Injuries

19980049001 Armed Forces Inst. of Pathology, Washington, DC United States
AVIATION PATHOLOGY NOTES
Cogswell, Steven C., Armed Forces Inst. of Pathology, USA; Feb. 1998; 12p; In English; See also 19980048994; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Topics discussed include the following: Aircraft Mishap Investigation; Survivability Analysis; Armed Forces Military Examiner; Injury Analysis; Control Injuries, and Toxicology.
Author
Aerospace Medicine; Aircraft Accidents; Injuries; Pathology; Toxicology; Survival

19990014355 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
LASER GENERATED 3-D SPACE DISPLAY IMAGES
Taboada, J., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 7-10; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Conventional techniques of forming three dimensional (3-D) images on a two dimensional screen involve the use of electronic or optical tricks, such as the use of special eyewear. In a 3-D space display, however, the images are formed directly from luminous points distributed in all three spatial dimensions. Instead of pixels, one has voxels (volume-pixels). There are a number of approaches currently under development for 3-D space displays, some holographic and others mechanical, but the goal is to achieve a 3-D space display with no moving parts and a full 360 degree view requiring no special eyewear. This goal is within reach through the use of new two-photon laser photoexcitation techniques where two laser beams of different wavelengths intersect in a special transparent media. Fluorescence is emitted at the intersection where the combinations of the excitations creates the emissions. By multiplexing the laser beams throughout the media, a solid display object can thus be synthesized. This presentation will review the state-of-the-art of 3-D space display technology and develop a prospectus for future applications in air traffic control and mission management.
Author
Display Devices; Visual Aids; Virtual Reality

19990025670 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
AEROMEDICAL SUPPORT ISSUES IN CONTINGENCY OPERATIONS *LE SOUTIEN AEROMEDICAL LORS DES OPERATIONS NON PROGRAMMEES*
September 1998; 420p; In English; In French, 29 Sep. - 1 Oct. 1997, Rotterdam, Netherlands; See also 19990025671 through 19990025721
Report No.(s): AGARD-CP-599; ISBN 92-836-0059-2; Copyright Waived; Avail: CASI; A18, Hardcopy; A04, Microfiche

These proceedings include the Technical Evaluation Report, two Keynote Addresses, 53 papers and the edited discussions of the Symposium sponsored by the North Atlantic Treaty Organization (NATO/RTO) Aerospace Medical Panel. It was held in Rotterdam, N-E from 29 September - 1 October 1997. Contingency Operations constitute military missions such as peacekeeping, humanitarian aid, peacemaking/enforcement, full scale offensive operations and relief operations other than war, such as aid to civil powers in counterterrorism and in natural disasters. Increasingly, these operations will involve greater NATO participation in the post "Post-Cold-War" era. Significantly, NATO nations are turning to the application of science and technology, particularly computer resources, to address the unique problems associated with Contingency Operations. From a medical standpoint, there are many logistic, support and environmental factors which impede effective health and critical care medicine in Contingency Operations. This Symposium considered both the aeromedical problems encountered and the role of technological solutions as aids to resolving the issues in: (a) sustained and continuous operations, (b) medical management in remote locations, (c) medical information, and (d) adaptation to operational conditions. These proceedings will be of interest to heads of military health services, military and civilian officers concerned with the health and safety of personnel in air and support operations, research scientists, and those requiring a state-of-the-art review of medical "lessons learned" in Contingency Operations.
Author
Conferences; Contingency; Medical Services; Operations Research; Research and Development; Human Factors Engineering; Medical Personnel; Telemedicine; Medical Equipment; Life Support Systems; Aerospace Medicine; Biological Effects; Aircraft Safety

19990025671 Royal Air Force, School of Aviation Medicine, Farnborough, United Kingdom
SUSTAINED AIR OPERATIONS: PROLONGED DUTY OVERNIGHT
Nicholson, A. N., Royal Air Force, UK; Stone, Barbara M., Defence Evaluation Research Agency, UK; Aeromedical Support Issues in Contingency Operations; September 1998; 14p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Sustained air operations imply round-the-clock scenarios and, inevitably, prolonged duty overnight. The ability of crews to cope with such work-rest patterns depends to a large extent on obtaining sufficient sleep during critical rest periods. Hypnotics may be essential to ensure sleep as the rest periods themselves are limited in number and duration, and occur at all times of the day and night. However, even if good sleep is attained during all the available rest periods, there may still be much difficulty in sustaining alertness during duty overnight, particularly if the duty periods themselves are prolonged. This paper deals with the use of various potential interventions to sustain alertness during intensive air operations.
Author
Prolongation; Night; Alertness; Human Factors Engineering; Flight Crews; Aircraft Safety; Flight Safety; Aerospace Medicine; Biological Effects

19990025672 Armstrong Lab., Brooks AFB, TX United States
AIRCREW PERFORMANCE DURING EXTENDED SIMULATED BOMBER MISSIONS
Whitmore, J., Armstrong Lab., USA; French, J., Armstrong Lab., USA; Armstrong, S., B-2 OT and E Team, USA; September 1998; 6p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Research was conducted to determine if fatigue impacted the performance of aircrew during long-duration bomber missions. Sustained flight in excess of 36 hours with only a minimal crew aboard was examined in two studies. Sixteen male USA Air Force B-1B bomber aircrew participated in the study. The participants served in crews of four and performed three 36-hour experimental periods (missions) in a high-fidelity B-1B simulator. The missions were interspersed with 36-hour rest breaks. Speech, cognitive, physiological (EEG, temperature), and subjective fatigue data were collected approximately every three hours for 11 trials per mission. A MANOVA analysis revealed a significant effect of trials for the aggregated measures (F(10,432) = 1.9885, p less than 0.0001). This result, along with trend analyses, indicated a strong diurnal pattern in nearly all of the dependent measures. End-mission performance was similar to beginning-mission performance. Crews were able to perform the missions successfully; however, several areas of increased risk due to fatigue were observed. Crew rest strategies prior to, during, and following a mission are discussed. A second study is described which evaluated three long-duration B-2 missions.
Author
Bomber Aircraft; Flight Crews; Pilot Performance; Flight Fatigue; Flight Safety; Aircraft Safety

19990025673 Paris V Univ., Lab. of Applied Anthropology, France
REST MANAGEMENT AND THE DEVELOPMENT OF SIGNS OF FATIGUE IN PILOTS ACCORDING TO WORK SHIFTS *GESTION DES REPOS ET EVOLUTION DES MANIFESTATIONS DE FATIGUE CHEZ LES PILOTES SELON LES ROTATIONS*
Mollard, R., Paris V Univ., France; Cabon, P., Paris V Univ., France; Mourey, F., Paris V Univ., France; Bougine, S., Paris V Univ., France; Coblentz, A., Paris V Univ., France; September 1998; 10p; In French; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Fatigue in airplane pilots constitutes one of the most often mentioned factors among reasons for reduced work performance.

One of the available sources of information concerns the ASRS (Aviation Safety Reporting System), which allows American crews to report incidents confidentially. Analysis of these responses indicates that fatigue is explicitly mentioned in 4% of the events. Nevertheless, one can assume that fatigue is partially responsible for more than 20% of these incidents, given that other factors, such as inattention and communication problems, are often cited. Moreover, when pilots refer to fatigue, its associated causes prove to be quite diverse. Some pilots attribute it to lack of sleep, whereas for others long workdays or heavy workloads constitute the main causes for fatigue. One of the most frequently seen areas of confusion concerns the concept of sleepiness. Many studies conducted in real-life situations suggest that sleepiness and fatigue represent different ideas.
Author
Work-Rest Cycle; Aircraft Pilots; Rest; Aerospace Medicine; Biological Effects; Flight Fatigue

19990025674 Armstrong Lab., Combined Stress Branch, Wright-Patterson AFB, OH United States
EVASIVE MANEUVERS AND HIGH-G FLIGHT SAFETY AFTER SLEEP DEPRIVATION
Chelette, T. L., Armstrong Lab., USA; Esken, R. L., Armstrong Lab., USA; Tripp, L. D., Armstrong Lab., USA; Albery, W. B., Armstrong Lab., USA; September 1998; 10p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

It is a common situation in the current global reach/global power mission to require fighter pilots to deploy overseas on short notice and to require immediate duty. Up to thirty six hours of sleeplessness is a common status in this environment. The objective of this study was to assess the performance of trained simulator pilots performing flight relevant tasks in the stressful environment of high G under two conditions; rested and 24 hours of sleeplessness. Performance was also compared to self-assessment and self reported effort and fatigue. Limited data was collected concerning a 2-4 week lay-off from the task. Volunteers (eight men & eight women) were trained to fly the Dynamic Environment simulator in a closed loop configuration air combat maneuvering up to 9 Gz. Before and after each session, their total body isometric strength was measured. During each sortie, thirty performance measures at simultaneous multiple tasks were measured. After each session, subjects completed a subjective questionnaire and a standardized subjective workload assessment. Neither male nor female overall performance was significantly affected by sleep status, although individual tasks showed sensitivity; call-sign reaction time was longer by 33% and missile survival was considerably less likely. Also, perceived effort and physical demand were higher while perceived performance was lower when sleepless. Greater self reported effort on the anti-G straining maneuver correlated with better task performance and less post-G fatigue. Men are naturally stronger than women, however there was no significant decrease in strength due to G exposure in either the rested or sleepless conditions for either gender. Though sleep deprived pilots' subjective sensations may be that they are fatigued and unable to perform, objective measures show that their ability to conduct offensive maneuvers remains unchanged after 24 hours without sleep. However, when conversion to uncertain and spatially demanding defensive maneuvers occurs, survival may be compromised.
Author
Sleep Deprivation; High Gravity Environments; Evasive Actions; Aircraft Maneuvers; Flight Crews; Pilot Performance; Aerospace Medicine; Bioastronautics; Biological Effects; Aircraft Safety

19990025675 Netherlands Aerospace Medical Centre, Soesterberg, Netherlands
PROS AND CONS OF STRATEGIC NAPPING ON LONG HAUL FLIGHTS
Valk, P. J. L., Netherlands Aerospace Medical Centre, Netherlands; Simons, M., Netherlands Aerospace Medical Centre, Netherlands; September 1998; 6p; In English; See also 19990025670
Contract(s)/Grant(s): CAA-97.058; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Long haul operations involve rapid multiple time zone changes and long, irregular work schedules. These factors can result in sleep loss, circadian disruption, and fatigue with consequent effects on pilot's performance and alertness. A controlled nap in the cockpit is considered to be a useful countermeasure to inflight fatigue. Therefore, a study was conducted on the effects of a 40 minutes controlled rest period on the flight deck on crew performance and alertness. The alertness of the designated waking pilot, who has to remain alert while his colleague is resting, was explicitly assessed. Data was collected of 59 pilots, flying North-Atlantic B747-300 trips as scheduled in their regular duty roster. Pilots were equipped with a palmtop computer and an actigraph for objective and subjective assessment of quantity and quality of cockpit naps, alertness, and performance on a vigilance dual-task. During flights, measurements were performed before and after the rest period and before top of descent. It was found that a cockpit rest period improved alertness and performance of the rested pilots up to top of descent. Sleep during the rest period provided more improvement than rest alone. A number of designated waking pilots had difficulties in maintaining a sufficient level of alertness during the rest period of their colleague pilot. It is recommended to implement the use of preplanned controlled rest periods on the flight deck as a preventive fatigue countermeasure in 2- and 3-person flight deck operations. Measures to safeguard the alertness of designated waking pilots and guidelines to secure flight safety are discussed.
Author
Flight Safety; Aircraft Safety; Aerospace Medicine; Biological Effects; Flight Operations; Sleep Deprivation

19990025676 Netherlands Aerospace Medical Centre, Soesterberg, Netherlands
EARLY STARTS: EFFECTS ON SLEEP, ALERTNESS AND VIGILANCE
Simons, M., Netherlands Aerospace Medical Centre, Netherlands; Valk, P. J. L., Netherlands Aerospace Medical Centre, Netherlands; September 1998; 8p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Early starts and irregular work schedules might lead to disruption of sleep-wake rhythms with consequent sleep loss and fatigue. Fatigue is known to be a contributing factor to operational errors. The aim of this study was to determine the effects of early reporting times and irregular duty schedules on sleep, alertness and performance of pilots flying short-haul operations. Method: 6 Captains flying short-haul charters were measured during two 4-week periods. Subjects were equipped with a palmtop computer and an actigraph for subjective and objective measurement of sleep parameters, alertness, and performance on a vigilance dual-task. Each day subjects had to perform measurements before, during, and after flights and before and after the main sleep period. Results: It was found that pilots reporting before 06:00 a.m. had a significant shorter total sleep time, impaired sleep quality, and impaired performance both pre-flight and at top of descent. to a lesser degree, this also applied for reporting between 06:00 and 09:00 a.m. Degradation of sleep was most significant during the night prior to the start of a new duty period. Conclusion: Performance was primarily affected by inadequate sleep related to reporting times before 06:00 a.m. It is recommended that reporting times before 06:00 a.m. should be avoided, whenever possible. Pilots who have to report early, should try to anticipate insufficient sleep by advancing their sleep phase. This can only be achieved when early starts are planned on a regular basis. When irregular early starts are unavoidable, it should be considered to compensate for sleep reduction by planning sufficient time for recovery sleep.
Author
Sleep; Alertness; Wakefulness; Flight Fatigue; Aircraft Safety; Flight Safety; Aerospace Medicine; Biological Effects; Work-Rest Cycle

19990025677 Lyon-1 Univ., Dept. de Medecine Experimentale, Lyon, France
NEUROBIOLOGICAL BASIS OF THE PHARMACOLOGICAL MANAGEMENT OF SUSTAINED ALERTNESS *BASES NEUROLOGIQUES DE LA GESTION PHARMACOLOGIQUE DE L'EVEIL*
Jouvet, Michel, Lyon-1 Univ., France; September 1998; 1p; In English; See also 19990025670; Copyright Waived; Avail: Issuing Activity; Abstract Only; Abstract Only

Since waking and sleep are regulated by two distinct systems, there are two different methods to increase the duration of waking, either by stimulating the waking systems or by inhibiting sleep-inducing mechanisms. Some advances in the understanding of the mechanisms of drugs acting upon the nervous system have been recently obtained by the development of immunohistochemistry of early genes. Among them, the immunohistochemistry of CFos protein

is a good index of the neural systems which are activated after injection of drugs in animals. These data will be summarized together with the study of sleep which occurs after sustained wakefulness.
Derived from text
Nervous System; Wakefulness; Alertness; Pharmacology

19990025678 Army Aeromedical Research Lab., Fort Rucker, AL United States
THE EFFICACY OF DEXTROAMPHETAMINE FOR SUSTAINING HELICOPTER PILOT PERFORMANCE: AN IN-FLIGHT EVALUATION
Caldwell, John A., Jr., Army Aeromedical Research Lab., USA; September 1998; 6p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The capability to operate 24 hours per day on the battlefield creates a tactical advantage over enemy forces. However, staffing shortages necessitating long work hours devoid of sleep eventually produce overwhelming fatigue, impairing performance and safety. In these situations, the only effective means to sustain performance may be the administration of stimulants. Unfortunately, studies of stimulants such as dextroamphetamine on the actual flight performance of aviators are virtually nonexistent. The present study assessed actual in-flight performance, mood, and alertness of UH-60 pilots during sleep-deprivation periods in which they were given either a 10-mg dose of Dexedrine or a placebo at 0000, 0400, and 0800 within the last 23 hours of each period. Results indicated better control (smaller RMS errors) of several flight parameters (i.e., heading, altitude, airspeed, etc.) under Dexedrine than placebo during straight-and-levels, climbs, descents, right turns, and a left-descending turn. Tendencies toward Dexedrine-related improvements also occurred in the left turns and the Instrument Landing System approach. The Profile of Mood States revealed reductions in fatigue, confusion, and depression concurrent with increases in vigor as a function of Dexedrine. Electroencephalographic data indicated enhanced central nervous system arousal under Dexedrine relative to placebo. No significant side effects occurred. It can be concluded that dextroamphetamine effectively sustained aviator performance during short-term sustained operations.
Author
Pilot Performance; Sleep Deprivation; Amphetamines; In-Flight Monitoring; Central Nervous System Stimulants

19990025679 Institut de Medicine Aerospatiale Armee, Bretigny sur Orge, France
PHARMACOLOGICAL SLEEP MANAGEMENT: INTEREST OF MODAFINIL *GESTION PHARMACOLOGIQUE DU SOMMEIL: INTERET DU MODAFINIL*
Lagarde, Didier, Institut de Medicine Aerospatiale Armee, France; September 1998; 8p; In French; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

During sustained and continuous operations the sleep-wakefulness cycle is often disturbed: jet-lag, shift lag, prolonged sleep deprivation. The vigilance management in operational conditions includes pharmacological and non-pharmacological countermeasures. Sometimes non-pharmacological countermeasures, i.e, preventive, ergonomic and physical measures become inefficient or are inapplicable, so in these cases, military research teams are looking for pharmacological measures. There is a great variety of substances which may be used to reduce the effects of these sleep disturbances. These substances have to take place in a straight rule which could be resumed in 4 points: 1) an easy ingestion; 2) a quick effect after treatment; 3) a modulating time duration effect, dose-function; and 4) without side effects. Generally, three kinds of substances could be used: 1) hypnotic substances to induce a recovery sleep; 2) wakening substances to maintain a good level of vigilance; 3) synchronizer to resynchronize biological rhythms after jet-lag. In this work, the author presents an interesting synthetic substance called Modafinil (MODIODAL(R)). This substance is a medicine used to treat narcolepsy and hypersomnia. But modafinil could also act in healthy subjects, for example during a long sleep deprivation, and maintain a good level of vigilance and performance during 60 hours of continuous wakefulness. A neuroprotector effect at high dose has been demonstrated. The action mechanism of modafinil is complex. Modafinil modulates (as agonist) central post-synaptic alpha 1 noradrenergic receptor (wakefulness effect). At high doses, it increases dopamine level in nucleus accumbens (locomotor effect). It has also an indirect participation in the serotoninergic system (wakefulness effect). It induces a decrease of cortisol liberation of the GABA (wakefulness effect), and induces moderate transient increase in aspartate and glutamate (wakefulness effect) followed by long lasting decrease of extra-cellular excitatory amino-acids (neuroprotector effect). Modafinil increases a brain metabolic energetic compound: the phosphocreatine, and it induces an activation of proto oncogen c-fos in anterior hypothalamic nucleus. Modafinil (MODIODAL(R)) appears as an interesting substance in SUSOPS and CONOPS, easy to take, with a dose-effect to modulate the action. No major side effect was described. It is a wakening substance and not an anti-sleep drug. Modafinil could be a very useful substance during real sustained operations but we have to take care of the wrong use.
Author
Pharmacology; Sleep Deprivation; Drugs; Wakefulness; Central Nervous System Stimulants

19990025680 Centre de Recherches du Service de Sante des Armees, La Tronche, France
MODAFINIL EFFECTS ON SPATIAL COGNITION DURING 60 HOURS OF SLEEP DEPRIVATION
Raphel, Christian, Centre de Recherches du Service de Sante des Armees, France; Esquivie, Dominique, Centre de Recherches du Service de Sante des Armees, France; Stivalet, Philippe, Centre de Recherches du Service de Sante des Armees, France; Cian, Corinne, Centre de Recherches du Service de Sante des Armees, France; Baranski, Joseph V., Defence and Civil Inst. of Environmental Medicine, Canada; Leifflen, Daniel, Centre de Recherches du Service de Sante des Armees, France; Poquin, Didier, Centre de Recherches du Service de Sante des Armees, France; Barraud, Pierre-Alain, Centre de Recherches du Service de Sante des Armees, France; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Modafinil is currently being investigated in the context of sustained military operations as a potential countermeasure to the effects of extensive sleep deprivation (SD) on human cognitive performance. The aim of this present study is to analyze SD and dose-related effects of Modafinil on spatial cognition according to information processing patterns. Six normal healthy French military personnel participated for 4 one-week testing sessions involving double-blind, placebo-controlled manipulation of three doses of Modafinil (50, 150 and 300 mg/24hrs) during 60 hours of SD. Cognitive tasks investigated spatial abilities. Information processing data analysis indicates that Modafinil effectiveness is to be qualified based on the dose of Modafinil and psychological processes. Thus, Modafinil has more important beneficial effects on the serial processes which govern the speed of attentive spotlight scanning of the visual field, but a lower effect on the decision making processes involved in the same task. Regarding sensory interactions between vestibular system and vision, low doses (50 et 150 mg/24hrs) of Modafinil have beneficial effects, while a dose of 300 mg/24hrs produces effects which are similar to those observed with a placebo. Lastly, Modafinil have beneficial effects on mental imagery processes, however its effectiveness on mental image accuracy seems to be restricted to 48 hours of SD while vigilance is still well-preserved. This experiment suggest that sensorial integration processes, working memory and control operators are the preference target site for SD and Modafinil.
Author
Central Nervous System Stimulants; Information Processing (Biology); Mental Performance; Sleep Deprivation; Cognition; Performance Tests

19990025681 Naval Action Force, Toulon, France
SLOW RELEASE CAFFEINE: A VALID PHARMACOLOGICAL COUNTERMEASURE
Sicard, B., Naval Action Force, France; Lagarde, D., Centre d'Enseignement et de Recherches de Medecine Aeronautique, France; Batejat, D., Centre d'Enseignement et de Recherches de Medecine Aeronautique, France; Chauffard, F., Nestle Research Centre, Switzerland; Enslen, M., Nestle Research Centre, Switzerland; Tachon, P., Nestle Research Centre, Switzerland; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Sleep deprivation and desynchronization due to night watch, continuous operations or jet lag induce sleepiness and a decrement in performances: studies have shown that caffeine can be an effective

countermeasure in such circumstances. We evaluated a slow release caffeine (SRC), which delays the mean peak plasma concentration and lowers the plasmatic Cmax. Tolerance of 600 mg SRC was assessed in a double-blind, placebo controlled, parallel-group study, involving 120 young adult males. This single dose of SRC was well tolerated by these rested subjects. Pharmacokinetic parameters were not influenced by acetylator status or caffeine use; however calmness and sleep onset were disturbed. Then in another experiment we evaluated in four sessions, 150, 300, 600 mg SRC and a placebo in 24 sleep deprived male and female subjects. Alertness and psychomotor performance were enhanced in both sex. The higher sensitivity to caffeine doses observed in the female group was related to greater susceptibility to sleep deprivation, and to increased salivary caffeine levels correlated with inferior body weight and use of oral contraceptives. Therefore the use of 300 mg SRC by fatigued subjects may significantly improve alertness and performance, with a wider acceptance and tolerance than other psychostimulants like dextroamphetamine.
Author
Caffeine; Psychomotor Performance; Pharmacology; Countermeasures; Performance Tests; Wakefulness

19990025682 Centre d'Enseignement et de Recherches de Medecine Aeronautique, IMASSA, Bretigny, France
COGNITIVE PERFORMANCE DURING A 64-HOURS SLEEP DEPRIVATION: INTEREST OF A SLOW RELEASE CAFFEINE *PERFORMANCES COGNITIVES DE SUJETS SOUMIS A UNE PRIVATION DE SOMMEIL TOTALE DE 64 HEURES: INTERET D'UNE FORME A LIBERATION PROLONGEE DE CAFEINE*
Doireau, P., Centre d'Enseignement et de Recherches de Medecine Aeronautique, France; Batejat, D., Centre d'Enseignement et de Recherches de Medecine Aeronautique, France; Chauffard, F., Nestle Research Centre, Switzerland; Enslen, M., Nestle Research Centre, Switzerland; Tachon, P., Nestle Research Centre, Switzerland; Pradella, S., Centre d'Enseignement et de Recherches de Medecine Aeronautique, France; Lagarde, D., Centre d'Enseignement et de Recherches de Medecine Aeronautique, France; September 1998; 12p; In French; See also 19990025670; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Sleep deprivation is a consequence of modern military warfare. It leads to mental and physical performance decrement. Historically, psychostimulants have been widely used in the military context. Among them, caffeine is the most commonly taken, thus not prescribed, substance to cope with fatigue. Caffeine increases the level of alertness and the cognitive performance of fatigued personnel. Nevertheless, this effect is transitory and leads to chronic consumption and well known side effects. Recently, a slow release (SR) caffeine has been designed by NESTEC to improve its usability in sleep deprivation context. We present some data of an experiment conducted to answer the two following questions: 1) is SR caffeine an effective substance to maintain a good level of alertness during a 64-hours sleep deprivation?; and 2) is it able to alleviate the performance decrement of subjects? We will focus here on the results of the last objective.
Author
Caffeine; Alertness; Mental Performance; Sleep Deprivation; Performance Tests; Cognition

19990025685 Universidad Complutense, Dept. of Physiology, Madrid, Spain
URINARY MELATONIN EXCRETION IN AIRLINE PILOTS SUBMITTED TO TRANSMERIDIAN FLIGHTS
Tresguerres, J., Universidad Complutense, Spain; Ariznavarreta, C., Universidad Complutense, Spain; Granados, B., Universidad Complutense, Spain; Martin, M., Universidad Complutense, Spain; Villanua, M. A., Universidad Complutense, Spain; Golombek, D., Universidad Complutense, Spain; Cardinali, D. P., Buenos Aires Univ., Argentina; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Endogenous biological circadian rhythms are present in the majority of behavioural and physiological variables of all living organisms. These rhythms are entrained to the external environment in which they live, and get desynchronized as a consequence of transmeridian flights. This study has investigated changes occurring in various biological markers in air line pilots during and after westbound (Madrid-Mexico) and eastbound (Madrid-Tokyo) flights. The results have been compared to those of a non flying control group over a 6 day period. A clear cut activity rhythm adapted to the local "Zeitgeber" was present over the whole period in controls as well as an evident rhythm in the urinary excretion of 6 sulfatoxy melatonin. Pilots showed alterations of the melatonin rhythm already on the day before of the flight, probably due to the desynchronizing effects of previous transmeridian flights. to Mexico, the rhythm remained adapted to Madrid in the first day and started to get adjusted to local time the second day. Pilots older than 50 years showed a higher resistance to change their excretory rhythm, to adjust to the local environment. The return flight to Madrid occurred in the middle of maximal 6 sulfatoxy melatonin excretion. Experimental subjects flying to Tokyo showed a complete disruption of the hormonal excretory, and of the activity rhythms. All subjects showed tiredness and anxiety at the end of the flights, being at a maximum when arriving to Tokyo. Pilots did not completely recover before the return flight.
Author
Aircraft Pilots; Hormones; Circadian Rhythms; Jet Lag; Desynchronization (Biology); Flight Stress (Biology); Human Performance; Physiological Effects

19990025686 Army Aeromedical Research Lab., Fort Rucker, AL United States
AVIATOR'S GROUNDING TIME AFTER MELATONIN ADMINISTRATION DURING RAPID DEPLOYMENT MISSIONS
Comperatore, Carlos A., Army Aeromedical Research Lab., USA; Wright, Darlene, Army Aeromedical Research Lab., USA; Day-Clayton, Melanie, Army Aeromedical Research Lab., USA; Riuvera, Pik, Army Aeromedical Research Lab., USA; Bey-Wright, Regina, Army Aeromedical Research Lab., USA; Kirby, Albert W., Universal Energy Systems, Inc., USA; September 1998; 10p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The determination of drug-induced grounding time for aviation personnel can be derived from the drug's half-life, the assessment of hangover effects, and the evidence that sleep, alertness, and cognitive functions are normal some time after administration. Melatonin's half-life has been reported at approximately 60 minutes. Its side effects, particularly in the case of low doses no greater than 1 mg, generally are limited to drowsiness during the first 2 h after administration. This would imply that grounding time would be minimal for regimens employing I mg or less. However, the use of melatonin in rapid military deployments depends upon the development of regimens which can induce large advances or delays of circadian rhythms in relatively short periods of time (1-2 days).
Derived from text
Circadian Rhythms; Hormones; Aircraft Pilots; Pilot Performance; Half Life

19990025687 Force d'Action Navale, Toulon, France
ZOLPIDEM, SLEEPINESS AND THE PSYCHOMOTOR CAPACITIES OF GROUND PERSONNEL AND PILOTS *ZOLPIDEM, VIGILANCE ET CAPACITES PSYCHOMOTRICES DE PERSONNELS AU SOL ET DE PILOTES*
Sicard, B., Force d'Action Navale, France; September 1998; 6p; In French; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

During extended operations, crews often suffer from fatigue linked to rest periods that are quantitatively or qualitatively insufficient. These episodes of sleep deprivation are caused by many factors: workload, desynchronization during deployments across several time zones or during repeated night missions (or flying the latter exclusively), inadequate environmental sleep conditions (noise, extreme temperatures), excitability due to operations and combat stress. The use of soporifics is one of several means for optimizing crew rest periods. The ideal soporific for this purpose should be able to induce rapidly a period of sleep that is equal in quality to approximately 5 hours of physiological sleep and has no residual effects upon awakening, even for complex tasks such as pilotage.
Derived from text
Sleep Deprivation; Psychomotor Performance; Pilots; Ground Crews; Workloads (Psychophysiology); Sleep

19990025688 Royal Air Force, Personnel and Training Command, Gloucester, United Kingdom
OPERATIONAL DETERMINANTS OF MEDICAL PLANNING
Gibson, T. M., Royal Air Force, UK; September 1998; 6p; In English;

See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Aeromedical evacuation is but one stage of medical treatment for surviving casualties of a military operation. Planning for aeromedical evacuation must take account of the overall medical estimate. This paper describes the factors that medical staffs have to take into account during the planning stage of military operation and draws attention to some of the lessons learned from recent operations.

Derived from text

Medical Services; Aerospace Medicine; Operational Problems; Evacuating (Transportation); Casualties

19990025689 Air Force Medical Center, 59th Medical Wing, Lackland AFB, TX United States

CASUALTY CARE FOR 2010 AND BEYOND

Hersack, Richard A., Air Force Medical Center, USA; Carlton, Paul K., Jr., Air Force Medical Center, USA; Farmer, Chris, Air Force Medical Center, USA; September 1998; 24p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper discusses the priorities from medical readiness which include: (1) provide "essential" care forward, i.e. switch from "definitive" care forward with emphasis on casualty prevention; (2) critical care capable evacuation system; (3) modularize deployable medical units.

Derived from text

Casualties; Prevention; Health

19990025690 Air Force Medical Center, 59th Medical Wing, Lackland AFB, TX United States

EXPERIENCES OF THE CRITICAL CARE AIR TRANSPORT TEAMS (CCATT) DURING OPERATION JOINT ENDEAVOR

Hersack, Rick, Air Force Medical Center, USA; Lawlor, Dennis, Air Force Medical Center, USA; Carlton, P. K., Jr., Air Force Medical Center, USA; Beninati, William, Air Force Medical Center, USA; Grissom, Thomas, Air Force Medical Center, USA; Morales, Carlos, Air Force Medical Center, USA; Derdak, Stephen, Air Force Medical Center, USA; Farmer, J. Christopher, Air Force Medical Center, USA; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

For the past year, Critical Care Air Transport Teams (CCATT's) from Keesler Medical Center, Keesler AFB, Mississippi and Wilford Hall Medical Center, Lackland AFB, Texas have been deployed to support Operation JOINT ENDEAVOUR (OJE), the NATO peace effort in Bosnia. This is the largest operation involving the use of the CCATT's to date. A CCATT consists of a physician specializing in intensive care medicine, a critical care nurse, and a cardiopulmonary technician. The CCATT uses transport monitors, ventilators, portable blood analyzers and other medical equipment commonly used in our medical centers' intensive care units. The CCATT augments the standard aeromedical evacuation aircrew so that critically ill or injured patients may be evacuated from forward areas to definitive care hospitals. Otherwise, field hospitals in forward areas would have to provide care for these patients until they were stable enough to travel unaccompanied, creating huge logistical demands, or provide a physician to accompany the patient during evacuation, leaving forward field hospitals understaffed. Providing increased clinical capabilities aboard patient evacuation flights is not new. Several other nations' military medical services have extensive experience using enroute care providers to manage critically ill or injured patients during evacuation. During one year of the OJE deployment, the CCATT's moved 44 patients in 42 missions. Of these patients, 22 required mechanical ventilation during the flight. Eight missions were transatlantic flights to return patients to treatment facilities in the USA. CCATT's also redeployed to support the evacuation of foreign nationals from Liberia and rescue operations after the Khobar Towers Bombing in Dhahran. With the end of the "Cold War", a shift in military medical planning now calls for a reduced medical presence in areas of conflict and a subsequent increased reliance on patient movements out of theater for definitive medical and surgical care. The CCATT concept is an effective solution that fills the need for long range critical care air evacuation and easily integrates into the current aeromedical evacuation system.

Derived from text

Air Transportation; Patients; Medical Services; Military Operations; Rescue Operations

19990025691 Aeromedical Evacuation Squadron (0043rd), Pope AFB, NC United States

EVOLVING DOCTRINE IN THE THEATER AEROMEDICAL EVACUATION SYSTEM (TAES): OPERATION JOINT ENDEAVOR/GUARD AND BEYOND

Miller, P. M., Aeromedical Evacuation Squadron (0043rd), USA; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

With an increase in contingency operations in the NATO theater of operations, the Theater Aeromedical Evacuation System (TAES) needs to be flexible to meet the ever-changing demands of both combat operations and military operations other than war. Recent evolution in USA medical evacuation policies have made it necessary for the TAES to also change the way it does business. This paper discusses the composition of the TAES, recent additions to the TAES, trends in US medical policies, and implementation of the TAES during Operation JOINT ENDEAVOR/GUARD.

Derived from text

Medical Services; Evacuating (Transportation); Military Operations; Air Transportation

19990025692 Air Force Medical Center, 59th Medical Wing, Lackland AFB, TX United States

THE MOBILE FIELD SURGICAL TEAM (MFST): A SURGICAL TEAM FOR COMBAT CASUALTY CARE IN THE INFORMATION AGE

Carlton, P. K., Air Force Medical Center, USA; Pilcher, John, Air Force Medical Center, USA; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

The current military medical system is designed to support 20th century combat: the forces involved in the conflict were large, powerful, and ponderous. Medical planning for conflicts such as these included several assumptions about the conditions involved (1) Discrete build-up phase - medical units would have time to assemble their assigned personnel and materials, and would be permitted to set up these facilities before use of the facilities would be required; (2) Large number of casualties; (3) Definitive care in theater - lines of battle were fairly stable; thus injured personnel would be treated in-theater until they reached a convalescent phase. At that point they would be returned to duty or evacuated from the theater; and (4) Traditional evacuation system - the Air Evacuation system would serve to transport patients who had been injured, but had essentially no ongoing requirements for medical care. The assets that were developed to meet the medical needs of these conflicts (the Air Transportable Hospital (ATH), Combat Support Hospital (CSH), and Fleet Hospital) are very capable and offer a variety of medically oriented services. They are essentially full-service hospitals packaged in a format that can be moved by air or sea. As full-service hospitals, they are quite large and heavy, and they require a significant amount of time and space to set up. The ATH (for example) is intended to be deployed in a modular or "building block" fashion, but this is implemented by bringing primary care capability into the theater first. Thus a full 50-bed ATH is necessary before trauma surgery or even an appendectomy can be performed. This set of equipment is packaged on 52 pallets, requiring airlift of seven C-141 aircraft.

Derived from text

Surgery; Support Systems; Air Transportation; Casualties; Deployment

19990025693 Air Force Medical Center, 59th Medical Wing, Lackland AFB, TX United States

THE PROVISION OF INTENSIVE CARE MEDICINE IN AUSTERE FIELD LOCATIONS

Farmer, J. Christopher, Air Force Medical Center, USA; Carlton, P. K., Jr., Air Force Medical Center, USA; Kilpatrick, Russell, Air Force Medical Center, USA; Derdak, Steven, Air Force Medical Center, USA; Hersack, Richard, Air Force Medical Center, USA; Morales, Carlos, Air Force Medical Center, USA; King, Jim, Air Force Medical Center, USA; Ramon, Jose, Air Force Medical Center, USA; Beninati, Bill, Air Force Medical Center, USA; Grissom, Thomas, Air Force Medical Center, USA; Lawlor, Dennis, Air Force Medical Center, USA; Guz, Evan, Air Force Medical Center, USA; Biggers, Butch, Air Force Medical Center, USA; September 1998; 5p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Technologic advances have made laboratory testing feasible at the bedside. Point-of-care testing (POCT) allows medical providers to assess a wide range of clinical conditions in a rapid fashion at the site of patient interaction. While POCT has begun to impact on the delivery of care in the hospital setting, its potential for use in remote, field environments or during aeromedical evacuation is just being realized. In the civilian setting, discussion of POCT focuses on regulatory guidance, cost effectiveness, and reimbursement. Little attention has been paid in the literature to expanding the use of these capabilities beyond the traditional hospital boundaries. In this paper, we will briefly review the development of POCT and the associated technology. In addition, we will discuss the potential role of POCT in the field using current technology. Finally, we will review the available literature on use of POCT in the field.
Derived from text
Evacuating (Transportation); Medical Services; Cost Effectiveness; Air Transportation

19990025694 School of Aerospace Medicine, Brooks AFB, TX United States
POINT-OF-CARE TESTING: CAN IT BE ADAPTED FOR THE FIELD ENVIRONMENT?
Grissom, Thomas E., School of Aerospace Medicine, USA; Lawlor, Dennis, Air Force Medical Center, USA; September 1998; 6p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Technological advances have made laboratory testing feasible at the bedside. Point-of-care testing (POCT) allows medical providers to assess a wide range of clinical conditions in a rapid fashion at the site of patient interaction. While POCT has begun to impact on the delivery of care in the hospital setting, its potential for use in remote, field environments or during aeromedical evacuation is just being realized. In the civilian setting, discussion of POCT focuses on regulatory guidance, cost effectiveness, and reimbursement. Little attention has been paid in the literature to expanding the use of these capabilities beyond the traditional hospital boundaries. In this paper, we will briefly review the development of POCT and the associated technology. In addition, we will discuss the potential role of POCT in the field using current technology. Finally, we will review the available literature on use of POCT in the field.
Author
Medical Services; Field Tests; Medical Equipment

19990025695 Air Force Medical Center, 59th Medical Wing, Lackland AFB, TX United States
USE OF POINT OF CARE (POC) LABORATORY DEVICES BY CRITICAL CARE AIR TRANSPORT TEAMS (CCATT) OF THE UNITED STATES AIR FORCE
Lawlor, Dennis, Air Force Medical Center, USA; Grissom, Thomas, School of Aerospace Medicine, USA; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Point of Care (POC) laboratory devices have recently been utilized in medical centers to provide rapid results at the bedside of critically ill patients. The locations most commonly targeted are the Intensive Care Unit, the Operating Room, the Recovery Room and the Emergency Room. The impetus to use these devices is to provide immediate, accurate results of several critical laboratory values, especially those values that can change quickly. Instruments that can measure pCO2, pO2, pH, hemoglobin, hematocrit, sodium, potassium, chloride, glucose, urea, and ionized calcium and provide results in several minutes are already available. Technological requirements for a POC device include being small (less than 10 pounds), use small quantities of blood, can use AC or DC current, and require a minimum of effort to calibrate.
Derived from text
Air Transportation; Potassium Chlorides; Sodium Chlorides; Emergencies; Patients; Hemoglobin; Glucose; Hematocrit

19990025696 Walter Reed Army Inst. of Research, Div. of Surgery, Washington, DC United States
LIFE SUPPORT FOR TRAUMA AND TRANSPORT (LSTAT(TRADEMARK)): A NATO LITTER-BASED CRITICAL CARE TRANSPORT PLATFORM
Pearce, F. J., Walter Reed Army Inst. of Research, USA; Wiesmann, W. P., Army Medical Research and Materiel Command, USA; Hale, J., Armstrong Lab., USA; Licina, J. R., Army Aeromedical Research Lab., USA; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

A significant portion of the military field medical footprint is currently consumed by post surgical patients, which according to current doctrine, must be stable before evacuation. This requirement results in a significant logistical burden for our ground forces. At present, we do not have adequate monitoring or therapeutic capabilities during ground or air transport to a definitive care treatment facility. In response to this need, we initiated a research and development activity to design and build a NATO-stretcher-based mini-intensive care unit that incorporates resuscitative and life-sustaining capabilities for field surgery and en route care. The LSTAT(trademark) has 3 basic components: (i) the base unit; (ii) a NATO stretcher; and (iii) a canopy that covers the entire patient. The LSTAT(trademark) base contains medical, diagnostic and therapeutic components while medical parameters, system performance data and user interactions are continuously monitored and logged by an on-board CPU. Provision is made for storage of up to 36 hours of physiologic and system performance data which can be uploaded to a local or remote host computer. When necessary, this data can also be communicated to the receiving hospital during evacuation for review by physicians to aid in their medical preparations for treatment. This facility provides a new life support capability for transport of marginally stable or unstable patients which integrates with existing NATO evacuation platforms.
Derived from text
Life Support Systems; Air Transportation; Physiology; Diagnosis; Surgery

19990025697 Defence and Civil Inst. of Environmental Medicine, Operational Human Engineering Group, North York, Ontario Canada
AN INTEGRATED MEDICAL MONITOR FOR AEROMEDICAL USE
Dyck, W. R., Defence and Civil Inst. of Environmental Medicine, Canada; Nichols, A., CME Telemetrix, Inc., Canada; September 1998; 8p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

As early as 1973, the Canadian Forces Medical System realized that medical monitoring of a casualty in the field, in the presence of an NBC threat, is very difficult. More recently, during the Gulf War, this deficiency was again addressed. A Canadian Forces (CF) requirement was written for a portable, integrated system for monitoring the vital signs of patients in the field, under adverse, unconventional conditions. Design considerations of such a device included that it be rugged, battery operated, easy to use, and yet be accurate enough to be useful as a monitoring tool. A project began, within the Canadian research and development branch, to identify existing technologies, to perform a feasibility study of developing the technology internally, and then to develop a vital signs monitor, if economical to do so. A CF version of a vital signs monitor was developed, and the technology was transferred to industry. The device, VITSEM 200 produced by CME Telemetrix, is described, and available for demonstration. The VITSEM 200 can be used to monitor heart rate, body temperature, and blood oximetry continuously, and blood pressure when required. It measures 14.7 x 9.3 x 5.4 cm and weighs approximately 390 g. A version of the device (less the blood oximetry capability) has been evaluated successfully in a simulated NBC environment, and in a helicopter - deemed to be two of the most demanding adverse scenarios. The VITSEM 200 is currently being acquired by the Department of National Defence in sufficient quantities for user evaluations. If the user evaluations are successful, it is anticipated that the VITSEM 200 will become a new and valuable tool within all the medical elements of the CF.
Derived from text
Aerospace Medicine; Casualties; Oximetry; Patients; Warfare

19990025698 Department of the Air Force, Nurse Corps, Brooks AFB, TX United States
SPINAL CORD INJURY TRANSPORT SYSTEM
Mason, Barbara-Marie, Department of the Air Force, USA; September 1998; 2p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

The USA Air Force Air Mobility Command (AMC) is tasked to provide the aeromedical evacuation of casualties in routine and contingency operations. to carry out this mission, AMC needs a medical support system suitable for transporting patients with spinal cord injuries and all types of extremity and cervical traction requirements. This

piece of equipment would be a Spinal Cord Injury Transport System (SCITS). The current method for transporting these patients is on the Stryker Turning Frame with a Collins Traction Device, for cervical traction. The system has been in use for over 20 years and is no longer logistically supported and must be replaced. The replacement system should provide a quality of care comparable to that available in fixed (ground) medical treatment facilities; i.e., a system that provides traction and kinetic therapy through incremental side-to-side rotation. Although SCITS will primarily be used for the previously mentioned patients, it would be beneficial and used for a variety of other patient conditions such as multiple trauma, burns, chest wounds, pulmonary complications, and post operative, depending on availability.
Derived from text
Spinal Cord; Injuries; Air Transportation; Evacuating (Transportation); Medical Services; Support Systems; Casualties

19990025699 Department of the Air Force, Nurse Corps, Brooks AFB, TX United States
ADVANCED HYBRID OXYGEN SYSTEM-MEDICAL
Mason, Barbara-Marie, Department of the Air Force, USA; September 1998; 2p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

In 1993, a human system need request was submitted by Air Mobility Command to the Human Systems Center Plans and Program Office. This document tasked the aeromedical systems division to determine the feasibility of a hybrid oxygen system that could support the flight crew, patients and passengers on board an aircraft. What is currently available for flight crew is a variety of oxygen systems. There are liquid oxygen (LOX) systems, gaseous oxygen and onboard oxygen generating systems. The Patient Therapeutic LOX system is currently used for the patient therapeutic oxygen and passenger supplemental oxygen onboard some aeromedical evacuation aircraft. The limitations of existing onboard oxygen generating systems are they are not capable of generating or storing sufficient oxygen to meet patient and passenger needs.
Derived from text
Aerospace Medicine; Oxygen Supply Equipment; Liquid Oxygen; Air Transportation; Evacuating (Transportation); Flight Crews; Medical Services

19990025700 School of Aerospace Medicine, Brooks AFB, TX United States
MECHANICAL VENTILATOR PERFORMANCE DURING AEROMEDICAL EVACUATION
Grissom, Thomas E., School of Aerospace Medicine, USA; Papier, Kenneth S., Air Force Medical Center, USA; Lawlor, Dennis, Air Force Medical Center, USA; Farmer, J. Christopher, Air Force Medical Center, USA; Derdak, Stephen, Air Force Medical Center, USA; September 1998; 8p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Current USA military medical planning calls for a decreased medical presence in areas of conflict with increased reliance on patient movements out of theater for more definitive medical and surgical care. As a result, the aeromedical evacuation system will be moving patients with critical conditions and injuries faster and further than during past contingencies. This will include the movement of an increasing number of patients requiring mechanical ventilatory support. Advances in ventilator technology have led to the introduction of smaller and more capable transport ventilators. Some of these ventilators use built in air compression devices which remove the necessity of carrying an external compressor. In addition, manufacturers have incorporated newer modes of ventilation to improve patient tolerance of mechanical ventilation and provide the user with route care capability for the critically injured or ill patient.
Derived from text
Ventilators; Oxygen Consumption; Military Operations; Evacuating (Transportation); Air Transportation; Medical Services

19990025701 Militair Hospitaal Dr. A. Mathijsen, Utrecht, Netherlands
THE USE OF ULTRASOUND IN MILITARY TRAUMATOLOGY
vanDalen, Albert, Militair Hospitaal Dr. A. Mathijsen, Netherlands; September 1998; 6p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

In the last decade ultrasound (US) has become a very important diagnostic tool in many areas of medicine, including traumatology. US is a reliable method to detect blood in the peritoneum. When a modern system and a skilled examiner are available the invasive diagnostic abdominal tap has become obsolete. Also hematothorax and hemopericard are easily diagnosed with US and diagnostic or evacuating puncture can safely be performed under US guidance. US can also evaluate organ damage, in particular of pheripheral anatomical structures. It may guide interventional procedures and is very helpfull in the detection of foreign bodies, not visible on conventional radiographs. For these reasons 21 portable US systems were purchased by the Netherlands armed forces in 1993, intended for use- next to X-ray equipment - in field hospitals with operating room facilities. Practical experience with the US systems was obtained during two years of "peacekeeping" activities in former Yugoslavia. Due to modern technology a further reduction in size with development of one hand hold systems with good imaging qualities will soon be realised. This allows US examination of injured patients on the battlefields. In case of many victims and limited capacities US may play an important role in triage.
Derived from text
Radiography; Imaging Techniques; Peritoneum; Blood; Ultrasonics

19990025702 Air Force Medical Center, 59th Medical Wing, Lackland AFB, TX United States
TRAUMA SURGERY FOR CONTINGENCY OPERATIONS: TEST BASED IMPROVEMENTS
Carlton, P. K., Air Force Medical Center, USA; Putnam, A. Tyler, Air Force Medical Center, USA; Bradley, Donald, Air Force Medical Center, USA; Coopwood, Joseph, Air Force Medical Center, USA; Pilcher, John, Air Force Medical Center, USA; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

This paper describes work undertaken at Wilford Hall Medical Center for testing and quantification of practice changes planned to facilitate the concept of "forward resuscitative surgery." This paper will begin by discussing the rationale for and composition of the Mobile Field Surgical Team (MFST). It n will then proceed to discuss the challenges that arose in the formation of the team and it's concepts of operation, with a description of several areas in which we have performed objective testing of the proposed new practices. I will describe our evaluation of the following areas: (1) instrument disinfection technique that does not use an autoclave; (2) live surgery using a pared-down equipment package; (3) trauma surgery without visible light; and (4) possible application of thermal imaging to commonplace medical care
Derived from text
Surgery; Procedures; Antiseptics; Thermal Mapping

19990025703 Air Force Medical Center, 59th Medical Wing, Lackland AFB, TX United States
TEMPORARY ARTERIAL SHUNTS FOR MANAGEMENT OF MAJOR EXTREMITY ARTERIAL INJURY: A FIELD EXPEDIENT BRIDGE TO DEFINITIVE SURGICAL RECONSTRUCTION
Dawson, David L., Air Force Medical Center, USA; Light, Jerry T., Air Force Medical Center, USA; Putnam, A. Tyler, Air Force Medical Center, USA; Kissinger, David P., Air Force Medical Center, USA; Bradley, Donald V., Air Force Medical Center, USA; September 1998; 8p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Shunts were successfully placed and patency maintained 24 hours in all 8 animals. Shunt malposition with subsequent thrombosis requiring thrombectomy and repositioning occurred in one pig during the 4th hour of the experiment; this was successfully corrected and the shunt remained patent throughout the remainder of the experiment. Flow data from two animals was not able to be analyzed-one developed malignant hyperthermia which caused a hyperdynamic state, skewing the data; and the second had incomplete flow data due to equipment malfunction. This graph depicts the flow data comparing he control and shunted limbs. Although the flow through the shunted limbs was significantly lower than that of the non-shunted ones ($p = 0.0015$), the shunted limbs remained warm and well-perfused without any clinical evidence of ischemia. Flow rates did not differ significantly over time in either the shunted or control limbs.
Derived from text
Arteries; Hyperthermia; Thrombosis; Surgery; Flow Velocity; Bypasses

19990025704 Hemosol, Inc., Etobicoke, Ontario Canada
BLOOD SUBSTITUTES IN CONTINGENCY OPERATIONS
Magnin, Anthony A., Hemosol, Inc., Canada; Carmichael, F. J. Lou, Hemosol, Inc., Canada; September 1998; 8p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

For many years there has been a concerted effort by both industry and the military to develop blood substitutes. Such products are expected to be well-suited for use in emergency/trauma settings where the timely provision of fully cross-matched blood for resuscitation and/or transfusion may be difficult and prohibitively expensive. The use of cell free hemoglobin solutions as a safe and effective adjunct or alternative to red blood cell transfusion has long intrigued and challenged medical practitioners dealing with the various aspects of trauma, elective and emergency surgery, and other branches of medicine. Interest in this field has been heightened by concerns of the safety of blood and blood products, particularly in terms of possible contamination with infectious agents. There are still concerns about transmission of blood-borne diseases during the "window period" when infectious agents may be present, but antibodies are not yet detectable in blood using current methods. In addition, the incidence of immune suppression, occasional accidental mismatching of blood and recipient, and the extent of both major and minor reactions associated with blood transfusion continue to cause concern.
Derived from text
Blood; Hemoglobin; Resuscitation; Contingency; Surgery; Cells (Biology)

19990025705 Ministry of Defence, Direzione Generale della Sanita Militare, Rome, Italy
A WORLDWIDE EPIDEMIOLOGICAL SURVEY ON THE INFRASTRUCTURE FOR PREVENTION OF COMMUNICABLE DISEASES IN THE MILITARY
dAmelio, R., Ministry of Defence, Italy; Heymann, D. L., World Health Organization, Switzerland; September 1998; 6p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Infectious diseases represent a heavy burden for mankind. In 1995 infectious diseases were responsible for more than 17 million (33%) of nearly 52 million deaths worldwide. Among these infectious diseases, 65% were those characterized by person-to-person transmission, such as the sexually and air-borne transmitted diseases, followed by food, water and soil-borne (22%), insect-borne (13%) and animal-borne (0.3%) diseases. They include, in order of importance, acute respiratory infections (4.4 million deaths/year), followed by diarrhoeal diseases (3.1 million deaths/year), tuberculosis (3.1 million deaths/year) malaria (2.1 million deaths/year), hepatitis B (1.1 million deaths/year), HIV/AIDS (greater than 1 million deaths/year), neonatal tetanus (500,000 deaths/year), whooping cough (355,000 deaths/year) and lastly roundworm and hookworm (165,000 deaths/year)
Derived from text
Infectious Diseases; Epidemiology; Prevention; Parasitic Diseases; Surveys

19990025706 Joint United Nations Programme on HIV/AIDS, Geneva, Switzerland
PREVENTION OF HIV INFECTION AND SEXUALLY-TRANSMITTED DISEASES IN CONTINGENCY AND PEACEKEEPING OPERATIONS
Kingma, Stuart J., Joint United Nations Programme on HIV/AIDS, Switzerland; September 1998; 6p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Armed forces personnel are at special risk for exposure to STDs and HIV. The HIV risks are related to sexual activity and injecting drug use, and they are much higher during deployment. Military readiness can be compromised by these diseases through sick leave, loss of training input, loss of experience/skills, and cost of replacement training. HIV-positive personnel jeopardise field safety of blood supplies during contingency operations. Providing first aid in the field is also more complicated, and interaction with the local population carries its special risks.
Derived from text
Infectious Diseases; Risk; Prevention

19990025707 Zurich Univ., Div. of Epidermiology and Prevention of Communicable Diseases, Switzerland
PRIORITIES IN IMMUNIZATIONS FOR PEACEKEEPING FORCES
Steffen, Robert, Zurich Univ., Switzerland; September 1998; 8p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Previous experience shows wide differences in the immunizations status among contingents arriving from different nations for peacekeeping missions. This seems to be due to lack of knowledge, lack of coordination, and lack of financial support. to obtain logical priorities for immunizations in peacekeeping forces, one must primarily assess the risk of infection, to a lesser degree consider the impact of infection. Host factors, legal aspects and vaccine safety and efficacy also play a role. Usually, peacekeeping missions take place in regions with impaired hygienic conditions, in non-immunes, the risk is greatest for hepatitis A, hepatitis B, thyphoid fever and measles in most countries. Yellow fever, Japanese encephalitis. poliomyelitis, and plague are of no concern at many destinations, but the risk may be substantial at others. Cholera, diptheria, rabies, tetanus and tuberculosis are a lesser, albeit almost worldwide risk for troops. Depending on the type of mission, immunization against influenza needs to be considered. Future oral vaccines against gastrointestinal infections may become relevant issues in the near future.
Author
Immunology; Infectious Diseases; Vaccines; Priorities; Risk; Safety

19990025708 School of Aerospace Medicine, Flight Medicine Branch, Brooks AFB, TX United States
COMPLIANCE WITH ANTI-MALARIAL PREVENTIVE MEASURES BY DEPLOYING USAF PERSONNEL FOR OPERATION ASSURED RESPONSE
Williams, Christopher S., School of Aerospace Medicine, USA; Aeromedical Support Issues in Contingency Operations; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

The results of this study also indirectly suggest that reducing exposure in-country is a very important factor. If keeping personnel indoors can be accomplished, mosquito bite exposure, especially during evening hours when they are most active in feeding, would be benefical. If sleeping indoors is accomplished with the issuance and proper use of mosquito netting.
Derived from text
Military Operations; Exposure; Insects; Nets

19990025709 Army Medical Research Inst. of Infectious Diseases, Operational Medicine Div., Fort Detrick, MD United States
AIR EVACUATION UNDER HIGH-LEVEL BIOSAFETY CONTAINMENT: THE AEROMEDICAL ISOLATION TEAM
Christopher, George W., Army Medical Research Inst. of Infectious Diseases, USA; Eitzen, Edward M., Jr., Army Medical Research Inst. of Infectious Diseases, USA; September 1998; 10p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Contingency operations in tropical environments and the potential use of biological weapons by adversaries place troops at risk for potentially lethal contagious infections. Examples include viral hemorrhagic fevers, plague, and zoonotic poxvirouses. Rapid diagnosis and basic research regarding countermeasures for such illnesses would be facilitated by evacuating a limited number of patients to a facility with containment laboratories. In order to safely evacuate such patients to our institute via military aircraft and to minimize the rick of transmission ti air crews, care givers, and civilian communities, the U.S. Army Medical Research In stitute of Infectious Diseases has developed an Aeromedical Isolation Team (AIT). The AIT is a rapid response team with worldwide airlift capability designed to evacuate and manage patients under high level containment. Teams consist of a physician, a registered nurse, and four to six medics. The teams are accompanied by a fully functioning diagnostic laboratory utilizing genetic typing methods and immunoassays. Protective equipment includes impermeable protective suits equipped with powered HEPA-

filtered respirators and patient isolators equipped with negative-air pressure, HEPA-filtered ventilation system. Technical aspects of AIT equipment, training, deployments, and capabilities are discussed.
Derived from text
Aerospace Medicine; Infectious Diseases; Viruses; Medical Science; Flight Crews

19990025711 Military Satellite Command, Command and Control Systems Electronic Systems Center, Hanscom AFB, MA United States
EVOLUTION OF A GLOBAL MILITARY AND CIVILIAN TELEMEDICINE NETWORK FOR THE 21ST CENTURY: NEAR FUTURE ON DEMAND, SPACE BASED DELIVERY OF MULTIMEDIA SERVICES
Evans, John A., Military Satellite Command, USA; Davidson, Frank, Massachusetts Inst. of Tech., USA; Sanders, Jay, American Telemedicine Association, USA; McInerney, Thomas G., Business Executives for National Security, USA; Brandon, William T., Mitre Corp., USA; Row, Lockard M., Row (Lockard M.), USA; September 1998; 22p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper stresses the more recent intraregional telemanagement and telemedicine efforts and synthesizes key success factors essential for evolving self-sustaining global telemanagement and telemedicine networks for the twenty-first century. Finally, future directions are proposed which could adapt these kinds of networks to bring about healthier military and civilian communities.
Derived from text
Telemedicine; Biotelemetry; Medical Electronics; Teleconferencing; Telecommunication; Military Operations

19990025712 Army Medical Research and Development Command, Telemedicine and Advanced Technology Research Center, Fort Detrick, MD United States
TELEMEDICINE IN SUPPORT OF OPERATIONS IN REMOTE LOCATIONS
Morris, Tommy, Army Medical Research and Development Command, USA; Vandre, Robert H., Army Medical Research and Development Command, USA; Rocca, Mitra, Army Medical Research and Development Command, USA; Roller, Jeffrey I., Army Medical Research and Development Command, USA; Salisbury, Timothy, Army Medical Research and Development Command, USA; September 1998; 1p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

USA military services deploy to isolated locations with integral medical support. In most small deployments the unit has a General Medical Officer and/ or a Physician's Assistant as well as a compliment of Medics to provide primary medical care to the assigned personnel. The goal of telemedicine is increase the quality of care given to the soldiers by providing access to specialty providers utilizing satellite communications and commercial off the shelf technologies.
Derived from text
Telemedicine; Deployment; Medical Science; Medical Equipment; Medical Electronics; Biotelemetry

19990025713 Air Force Medical Center, 59th Medical Wing, Lackland AFB, TX United States
THE POTENTIAL USES OF TELEMEDICINE TO AUGMENT CRITICAL CARE IN-THE-AIR
Farmer, J. Christopher, Air Force Medical Center, USA; Carlton, P. K., Jr., Air Force Medical Center, USA; Kilpatrick, Russell, Air Force Medical Center, USA; Derdak, Steven, Air Force Medical Center, USA; Beninati, Bill, Air Force Medical Center, USA; Grissom, Thomas, Air Force Medical Center, USA; September 1998; 3p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Recent advances have allowed us to expand the relm of intensive care medicine into the aeromedical evacuation arena. The rate limiting step to the full scale development of this concept is sufficient numbers readiness directed numbers would not be gainfully employed during a peace time environment. Therefore, we must look to alternate personnel sources to provide this care with sophisticated medical backup. In this regard, telemedicine provides an excellent vehicle to leverage the sophisticated medical care into the hands of other healthcare providers with intensivists backup. Air to ground telemedicine may expand the functionality of available non-physical providers during military medical contingency operations.
Derived from text
Telemedicine; Military Operations; Medical Services; Air Transportation; Medical Equipment; Teleconferencing

19990025714 Georgetown Univ., Medical Center, Washington, DC United States
LIGHT WEIGHT AND PORTABLE TELEMEDICINE WORKSTATIONS: THE MUSTPAC EXPERIENCE
Macedonia, Christian R., Georgetown Univ., USA; Littlefield, Rik, Georgetown Univ., USA; Eglinton, Gary, Georgetown Univ., USA; Skelly, Larry, Georgetown Univ., USA; September 1998; 3p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Advanced imaging and telecommunications capabilities are becoming commonplace in major university hospitals. The availability od such services to people in remote or deployment environments is not always certain. to address this issue, the US Army and Battelle Memorial Institute developed a family of telemedicine workstations. One device, the MUSTPAC (Medical UltraSound, Three-dimensional and Portable with Advanced Communications) was deployed to the 212th Mobile Army Surgical Hospital in Tuzla, Bosnia-Herzegonvina in a feasibility study investigating its potential as a remote diagnostic tool.
Author (revised)
Telemedicine; Imaging Techniques; Ultrasonics; Military Operations

19990025715 Air Force Medical Center, Telemedicine Technology Area Directorate, Lackland AFB, TX United States
STATRAD: A PORTABLE IMAGING CENTER FOR REMOTE/ HOSTILE ENVIRONMENTS
Freckleton, M. W., Air Force Medical Center, USA; Johnson, Thomas G., Army Medical Research and Materiel Command, USA; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Until very recently, radiological imaging centers have been restricted to large medical institutions within large, fixed facilities. Although there is no diminution in the need for factors including equipment size, weight, power/water supply, narrow temperature thresholds, etc., have precluded all but the most rudimentary radiological imaging in austere locations. StatRad is an ongoing effort to develop not only imaging equipment, but the components of an integrated and scaleable imaging center for use in circumstances which cannot be controlled for environmental factors, and where the medical response must rapid and decisive.
Derived from text
Imaging Techniques; Radiology; Image Classification; Image Enhancement; Aerospace Medicine

19990025716 Militair Hospitaal Dr. A. Mathijsen, Dept. of Radiology, Utrecht, Netherlands
TELERADIOLOGY IN THE ARMED FORCES OF THE NETHERLANDS
Prins, H. J., Militair Hospitaal Dr. A. Mathijsen, Netherlands; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

In general terms the telemedicine project of the Armed Forces of the Netherlands is described. The system is not suited for use during acute situations in the field with large numbers of casualties. The surgical team will then be busy with life and limb saving procedures. In a later phase the results of the treatment. Problems experienced in the past are discussed. Telemedicine will never be a substitution for medical or surgical expertise in the field.
Derived from text
Telemedicine; Teleconferencing; Medical Services; Biotelemetry; Substitutes; Armed Forces; Casualties

19990025717 Mobile Army Surigical Hospital (212th), United States
CONTINGENCY OPERATIONS: THE CHALLENGING NEW PARADIGM
Moloff, Alan L., Mobile Army Surigical Hospital (212th), USA; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

For almost 50 years NATO forces planned and trained for the defence of western Europe. The fall of the Soviet Union and the breakup of the Warsaw Pact has greatly changed the focus of NATO and other military forces is Contingency Operations (CONOPS). This paper will discuss planning factors and considerations for medical support of CONOPS.
Derived from text
North Atlantic Treaty Organization (NATO); Contingency; Peacetime; Military Psychology; Psychological Effects

19990025718 Centro de Instruccion de Medicina Aeroespatial, Madrid, Spain
STRESS FACTORS IN THE SPAF PERSONNEL ASSIGNED TO HUMANITARIAN AND PEACE KEEPING OPERATIONS
Cruz, Jesus Medialdea, Centro de Instruccion de Medicina Aeroespatial, Spain; Tejada, Francisco Rios, Centro de Instruccion de Medicina Aeroespatial, Spain; September 1998; 12p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this paper we describe and analyze the stress factors associated to a sample of military personnel currently in flying status, who has been deployed in critical area where a wide range of missions has been conducted. In addition to that, we have studied the adaptation to the possible techniques to minimize such aeromedical issue. In order to evaluate this medical aspects, an interview and survey of factors related to perception of stress has been conducted according to a cognitive model of stress.
Derived from text
Stress (Psychology); Peacetime; Military Operations; Military Psychology; Psychological Tests; Psychological Effects

19990025719 National Defence Headquarters, Personnel Research Team, Ottawa, Ontario Canada
A CONCEPTUAL APPROACH TO THE STUDY OF STRESS IN PEACEKEEPING PERSONNEL
Murphy, P. J., National Defence Headquarters, Canada; Farley, K. M. J., National Defence Headquarters, Canada; Dobreva-Martinova, T., National Defence Headquarters, Canada; September 1998; 3p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

This paper outlines the current conceptual model utilized in Canadian Forces psychological research of the stress of peace operations. The model incorporates stressor, moderator, outcome and intervention components at the individual, group and organizational levels. Previous research has illustrated many of the various sources of stress on peace operations. Individual and organizational level resources that could serve as moderators of operational stress include individual coping skills, satisfiers of the peacekeeping experience, perceived organizational support and unit climate. Outcome measures include signs and symptoms of stress: both commonplace and more serious stress reactions. Other outcome and intervention components will be explored in future research. This theoretical framework should aid our understanding of the human dynamics of the deployment cycle and suggest appropriate training and interventions to enhance individual and organizational well-being and performance.
Derived from text
Stress (Psychology); Peacetime; Military Psychology; Psychological Effects; International Cooperation

19990025720 National Defence Headquarters, Personnel Research Team, Ottawa, Ontario Canada
STRESS IN PEACE SUPPORT OPERATIONS: RECENT CANADIAN EXPERIENCES
Murphy, P. J., National Defence Headquarters, Canada; Farley, K. M. J., National Defence Headquarters, Canada; Dubreva-Martinova, T., National Defence Headquarters, Canada; Gingras, C., National Defence Headquarters, Canada; September 1998; 4p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

The Canadian Forces continues its high profile involvement in peace operations in various parts of the world. At present, over 2000 Canadian Forces personnel are deployed overseas in the peace support roles, largely in Bosnia and Haiti. A long-term research project into the human dimension of operational performance has monitored several aspects of deployments. The paper addresses research findings relating to the stress of peace support operations and other human factors. Select details of significant stressors, the stress-strain relationship and several moderating factors (satisfiers, group cohesion, coping styles and perceptions of organizational support) are presented.
Derived from text
Military Psychology; Military Operations; Human Performance; Perception; Personnel; Stress-Strain Relationships; International Cooperation

19990025721 Army of the Czech Republic, SFOR Monitoring Center, Prague, Czechoslovakia
MOTIVATION STRUCTURES OF THE CZECH SFOR UNIT MEMBERS
Radova, Jana, Army of the Czech Republic, Czechoslovakia; September 1998; 7p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Army of the Czeach Republic has been actively participating in the peace-keeping missions of the United Nations and NATO from 1991 until today. The goal of this paper is to describe the motivation structures that led our soldiers to participate in the last of the mentioned missions.
Derived from text
North Atlantic Treaty Organization (NATO); Military Operations; Peacetime; International Law; International Cooperation

53
BEHAVIORAL SCIENCES

19950027632 Air Force Inst. of Aviation and Space Medicine, Moscow, Russia
SELECTION AND SPECIAL PHYSIOLOGICAL TRAINING OF FLYING PERSONNEL TO HIGH +G(Z)-MANEUVERABLE FLIGHTS-MAIN CONCEPT
Stupakov, G. P., Air Force Inst. of Aviation and Space Medicine, Russia; Khomenko, M. N., Air Force Inst. of Aviation and Space Medicine, Russia; AGARD, Current Concepts on G-Protection Research and Development; May 1, 1995, 15 p; In English; See also 19950027629; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

For insurance of the complete and efficient protection of flyers from exposure of high-sustained and rapid onset rate +Gz-acceleration profiles, together with administration of modern sophisticated counter-G technical appliances, individual physiological tolerance of flyer to the effects of high level Gz stress plays an important role. The necessity of practical implementation of methods of determination of Gz acceleration tolerance to high-sustained +Gz-stress for selection are verified, along with carrying-out of special physiological preparation of flyers in order to magnify their tolerance to such effects. The results of study are presented of health and special physiological preparedness on pilot's individual tolerance to high-sustained +Gz-accelerations. The procedure and criteria of determination of pilot's ability to tolerate high level +Gz-accelerations in centrifuge tests for selection to transition and mastering the high performance fighter-aircraft of type MIG-29 and SU-27 are disclosed. The possibility of individual pilot's tolerance to high sustained +Gz-acceleration prediction is proved, based on data of statoergometric functional loading test on special physical trainer 'Statoergometer'. For enhancement of flyers' tolerance to high-sustained +Gz-acceleration the complex of means and ways of special physiological preparation involves carrying-out of ground and simulator training, course of physical training exercises on special trainers, realization of training centrifugation runs, and special infight training in aerobatic sorties. The methodological particularities of carrying-out and efficiency of various kinds of above mentioned special preparation of flyer are analyzed and the probable prospective ways of its further improvement are discussed.
Author
Acceleration Tolerance; Aerospace Medicine; Aircraft Pilots; High Acceleration; Human Centrifuges; Physical Exercise; Physiological Tests; Pilot Selection; Pilot Training; Training Simulators

19950027638 German Air Force, Inst. of Aviation Medicine., Koenigsbrueck, Germany
SELECTION AND TRAINING OF MIG-29 AND FUTURE FIGHTER PILOTS
Welsch, H., German Air Force, Germany; AGARD, Current Concepts

on G-Protection Research and Development; May 1, 1995, 10 p; In English; See also 19950027629; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

With the reunification on 3 Oct. 1990 the German Air Force took possession not only of 24 MiG-29 modern fighter aircraft, but also of the human centrifuge at Koenigsbrueck near Dresden, Saxony. Until now the MiG-29 is the only high performance fighter aircraft of the German Air Force whose pilots need training in a human centrifuge in accordance with the STANAG 3827. The Office of the Surgeon General GAF took the occasion to generate a new basic program for the German Air Force (GAF) not only for the few pilots of the MiG-29, but for the future fighter pilot generation. The program includes the preselection of young pilot candidates on a voluntary basis to exclude candidates without normal physiological cardiovascular reflexes against acceleration forces, the training of student pilots of fighter aircraft before starting fighter pilot school, and the training and qualification program for fighter pilots, for flying the MiG-29 fighter aircraft or other high performance aircraft such as F-16, F-18, and Mirage 2000 as exchange pilots in the USAF, the CAF, or in France.

Author

Acceleration Tolerance; Aircraft Pilots; Fighter Aircraft; Human Centrifuges; Pilot Selection; Pilot Training

19960023107 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France

SITUATION AWARENESS: LIMITATIONS AND ENHANCEMENT IN THE AVIATION ENVIRONMENT *LA CONSCIENCE DE LA SITUATION: LES LIMITATIONS ET L'AMELIORATION EN ENVIRONNEMENT AERONAUTIQUE*

Jan. 1996; 272p; In English; In French; Aerospace Medical Panel Symposium, 24-27 Apr. 1995, Brussels, Belgium; See also 19960023108 through 19960023133

Report No.(s): AGARD-CP-575; ISBN 92-836-0021-5; Copyright Waived; Avail: CASI; A12, Hardcopy; A03, Microfiche

These proceedings include the Technical Evaluation Report, two keynote addresses and 25 papers from the Symposium sponsored by the Aerospace Medical Panel and held in Brussels, Belgium 24-27 April 1995. Situational Awareness is seen as key to mission success and aircraft safety. There are several questions that the Symposium addressed: how effectively Situation Awareness can be measured, whether it is possible to select for it and whether training strategies can improve it. The Symposium also examined the research carried out into the contribution of new Cockpit Technologies to enhance it. Loss of Situation Awareness has been the predominant cause of fatal accidents in both military and civil aviation and several examples were cited where the aircraft had been lost or put in jeopardy due to pilot error. These proceedings will be of interest to those involved in cockpit system design, human performance, human perception, cognition and accident investigation.

Author

Aircraft Safety; Accident Investigation; Cockpits; Human Performance; Systems Engineering

19960023108 Defence and Civil Inst. of Environmental Medicine, North York, Ontario Canada

LOSS OF AVIATION SITUATION AWARENESS IN THE CANADIAN FORCES

Cheung, Bod, Defence and Civil Inst. of Environmental Medicine, Canada; Money, Ken, Defence and Civil Inst. of Environmental Medicine, Canada; Sarkar, Paul, Defence and Civil Inst. of Environmental Medicine, Canada; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 1-1 - 1-8; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The ability of a pilot to maintain situation awareness has been recognized as crucial to mission success for some time. Situation awareness has been used to refer narrowly to a combination of tactical awareness and spatial orientation. However, situation awareness is the accurate perception and comprehension of a number of factors and conditions that could affect the aircraft and the air crew within a period of time. The present study concentrates on accidents and incidents in which there was a loss of situation awareness excluding spatial disorientation . Each accident and incident were systematically reviewed to assess the role of situation awareness. Loss of situation awareness has been implicated in many close calls and accidents. A total of 64 mishaps between 1982-1993 were found to be related to loss of situation awareness in the Canadian Forces (CF) and it appeared throughout all mission and aircraft types. A focused and structured training program in managing cockpit resources and in maintaining attention would assist air crew in identifying conditions where situation awareness could potentially be lost and where appropriate strategies could be used to avoid the loss or to deal with the loss. Such training could be implemented through real-time man-in-the-loop flight simulator training of pilots in various flight scenarios. Similar training could also improve the performance and efficiency of air traffic controllers.

Author

Pilot Training; Flight Crews; Education; Cockpits

19960023109 Spanish Air Force, 23th Wing., Talavera AFB, Spain

LOSS OF AVIATION SITUATIONAL AWARENESS CAUSED BY A BIRD-AIRCRAFT COLLISION

Garcia-Alcon, Jose L., Spanish Air Force, Spain; Moreno-Vazquez, Juan M., Spanish Air Force, Spain; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 2-1 - 2-3; In English; See also 19960023107; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The history of aerial combat shows that tactical mission effectiveness depends on a few of the superior fighter-attack pilots. These few superior pilots appear to possess a heightened situational awareness that is decisive in the complex and highly fluid air combat environment. Pilot situational awareness is not a well understood concept. Most attempts at understanding situation awareness have relied almost exclusively on subjective reports, and have not led to a clear understanding of the concept. One approach to lending structure to defining situational awareness measures is to decide the information elements the pilot uses to develop an adequate 'state of knowing' concerning specific tasks, and to optimize the mission performance. Operational requirements for situational awareness have implications for flight safety and combat effectiveness. After a series of interviews with air combat experts, some authors developed a taxonomy of skills, traits and performance measures important for air-to-air combat which included aggressiveness, decisiveness, hands-on flying skills, knowledge, ability and situational awareness. This last concept was described as 'probably the sum of many perceptual and cognitive skills'. In 1984, loss of situational awareness was cited as a probable contributory factor in twenty out of forty one USAF operator-factor accident review. and loss of situational awareness is related to and a potential contributor to spatial disorientation. However, situational awareness is intended to be a more wide term encompassing more than spatial disorientation references and include more clearly psychological aspects of attention and cognition as well as sensory physiology considerations. In addition, future combat aircraft should be capable of flying anywhere, anytime and to engage air-to-air or air-to-ground attacks against a very unfavorable ratio of enemy forces. It is a clear consequence that the pilot's role will ever more turning to supervisory control, handling engines and the managing short term tactical decisions. In this way, and because the airplanes are of comparable technology in various countries, the quality of situational awareness will probably explain the pilot's variation of performance. Here we report a case in which the loss of situational awareness was the secondary consequence of an incident, and was on the point of provoking a fatal accident itself.

Derived from text

Bird-Aircraft Collisions; Flight Safety; Fighter Aircraft

19960023110 Armstrong Lab., Brooks AFB, TX United States

DETERMINANTS OF SITUATIONAL AWARENESS IN US AIR FORCE F-15 PILOTS

Carretta, Thomas R., Armstrong Lab., USA; Ree, Malcolm James, Armstrong Lab., USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 3-1 - 3-10; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Situational awareness (SA) is often cited as essential in pilot performance in both military and civil aviation. A study was conducted to investigate whether SA in U.S. Air Force (USAF) F-15 pilots could be predicted using the constructs of general cognitive ability, psychomotor ability, personality, and previous job (i.e., flying) experience. These constructs were chosen because they have demonstrated validity for the prediction of performance in a wide variety of military and civilian jobs, including pilots. The participants were 171 active duty

F-15 A/C pilots. Test scores, flying experience data, and supervisor and peer ratings of SA were collected at the pilots' duty locations. The first unrotated principal component extracted from the supervisor and peer ratings accounted for 92.5 percent of the variability of the ratings, which indicated substantial agreement between supervisors and peers. The unrotated first principal component was used as the measure of job performance (i.e., SA). Flying experience as measured by number of hours in the F-15 was the best predictor of SA. After controlling for the effects of F-15 experience, the measure of general cognitive ability based in divided attention, spatial reasoning, and working memory was predictive of SA. Psychomotor and personality measures did not add to the predictiveness of general cognitive ability. With additional F-15 flying experience, it is expected that pilots would improve their SA ratings. Implications for pilot selection and follow-on research are discussed.
Author
Aircraft Pilots; F-15 Aircraft; Pilot Performance; Performance Prediction; Human Performance; Mental Performance

19960023111 Systems Research Labs., Inc., San Antonio, TX United States
NEAR-THRESHOLD VISUAL PERCEPTION AND MANUAL ATTITUDE TRACKING: DUAL-TASK PERFORMANCE AND IMPLICATIONS FOR SITUATIONAL AWARENESS
Beer, Jeremy M. A., Systems Research Labs., Inc., USA; Gallaway, Robert A., Systems Research Labs., Inc., USA; Previc, Fred H., Armstrong Lab., USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 4-1 - 4-11; In English; See also 19960023107; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This study tested viewers' near-threshold recognition throughout the visual field, examined the effect of this task on a concurrent tracking task, and tested whether individuals' performance on each cockpit task would predict dual-task performance. An underlying assumption was that efficient multitasking supports SA. Experiment 1 measured recognition duration thresholds at different non-foveal locations. Subjects classified briefly-presented aircraft as fighters or non-fighters. An adaptive procedure adjusted viewing duration to reach 75% performance. Critical tracking ability was assessed also, using a central attitude display. Recognition deteriorated with eccentricity, and a wide distribution of threshold recognition and tracking abilities was found. Experiment 2 combined the two tasks; instructions emphasized recognition as primary. Measures included decrease in recognition accuracy, change in response latency, and increase in tracking RMS in dual-task conditions. Thresholds from Experiment I predicted dual-task recognition (viewers requiring longer durations classified fewer aircraft correctly), but not the increase in tracking error. Under dual-task stress, viewers with low recognition thresholds were less likely to abandon that primary task early in favor of tracking. Notably, critical tracking ability was linked to success preserving aircraft recognition: Viewers who tolerated higher instability before crashing suffered less in dual-task recognition. Field biases were identified in near-threshold performance under workload; this parallels visual search findings and is consistent with a spatially biased attention system. Findings are potentially relevant to SA assessment/selection and to the design of cockpit displays.
Author
Visual Perception; Cockpits; Display Devices; Human Performance; Workloads (Psychophysiology)

19960023112 Armstrong Lab., Neuropsychiatry Branch., Brooks AFB, TX United States
DEVELOPMENT OF TECHNIQUES TO IDENTIFY INDIVIDUALS WITH SUPERIOR POTENTIAL FOR SITUATIONAL AWARENESS
King, R. E., Armstrong Lab., USA; Flynn, C. F., Armstrong Lab., USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 5-1 - 5-6; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Certain cognitive abilities and personality traits may be conducive to the development of situational awareness. The USA Air Force Neuropsychiatrically Enhanced Flight Screening (N-EFS) program screens pilot candidates before they enter undergraduate pilot training (UPT). The Multidimensional Aptitude Battery (MAB), a highly timed IQ test, and CogScreen, a computer-based cognitive test, are now administered to all UPT candidates. CogScreen measures attention, memory, visual scanning, response speed, visual-spatial orientation, capacity for divided attention, and resistance to response interference. CogScreen approximates and measures response to the multiple, competing activities requiring prompt and prioritized attention. Traditional neuropsychological tests do not gauge the subtle abilities that performance in a high-demand environment requires on account of their clinical, rather than occupational, emphasis. The Personal Characteristics Inventory (PCI) and the Revised NEO-Personality Inventory (NEO-PI-R) comprise the optional (requiring participant informed consent) portion of NEFS. PCI measures decision-making strategies and interpersonal style, gauging potential for effective crew resource management. The NEO-PI-R may suggest optimal personality styles for developing situational awareness in particular aircraft. Preliminary results suggest that prospective pilots have a wide range of intelligence and cognitive ability (from average to very superior) and distinct personality styles. Testing results captured prior to the commencement of training will be compared to occupational outcome (whether or not the candidate became a mission-ready pilot) to assess their predictive value in the development of situational awareness.
Author
Psychological Tests; Personality; Pilot Training; Abilities; Cognitive Psychology; Mental Performance

19960023113 Defence Research Agency, Farnborough, Centre for Human Sciences., Hampshire, United Kingdom
SITUATIONAL AWARENESS, TRUST, AND COMPATIBILITY: USING COGNITIVE MAPPING TECHNIQUES TO INVESTIGATE THE RELATIONSHIPS BETWEEN IMPORTANT COGNITIVE SYSTEMS VARIABLES
Taylor, R. M., Defence Research Agency, Farnborough, UK; Shadrake, R., Defence Research Agency, Farnborough, UK; Haugh, J., Defence Research Agency, Farnborough, UK; Bunting, A., Defence Research Agency, Farnborough, UK; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 6-1 - 6-14; In English; See also 19960023107; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Situational awareness (SA), trust, and compatibility are considered as variables associated with cognitive systems. Three studies are reported investigating the relationships between these variables using experimental methods, subjective ratings, and cognitive mapping techniques. In the first study, a computer simulation of an Air Traffic Control (ATC) task was used to investigate the relationship between task performance and subjective estimates of situational awareness using the Situational Awareness Rating Technique (SART). The results show a strong association between rated SA and performance, and provide evidence of the predictive power of a unitary SART index. In the second study, a simulated aircraft task environment was used to investigate the effects of unreliable computer aiding on task performance, and ratings of SA, and of attitudes associated with trust in task automation. The results show evidence of performance compensation without awareness of automation failure. Trust was associated with attitudes to computer performance; task performance was associated with ratings of understanding. In the third study, a task requiring directional responses to a multi-modal display of situational information was used to elicit personal constructs associated with the cognitive compatibility (CC) of the task. Constructs were elicited using the Repertory Grid procedure. Analysis of subjective ratings of the construct dimensions indicate the multi-dimensional structure of the constructs associated with CC namely: ease or difficulty of reasoning and understanding; depth of processing or stimulus-response compatibility; learning, and experience or schema compatibility. The development of tools for the subjective measurement and prediction of SA and cognitive compatibility is discussed.
Author
Human Performance; Tasks; Air Traffic Control; Computer Systems Performance

19960023114 British Aerospace Aircraft Group, Bristol, United Kingdom
SITUATIONAL AWARENESS MEASUREMENT IN COCKPIT EVALUATION TRIALS
McGuinness, Barry, British Aerospace Aircraft Group, UK; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 7-1 - 7-8; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Maintaining good situational awareness has always been a necessary task for pilots. However, the influx of more and more new

technological capabilities in aircraft systems and the growing demands made by these on the pilot's attention has highlighted the vulnerability of situational awareness and its critical effects on pilot performance and mission success. In developing and evaluating novel displays and other new cockpit systems, measuring any differences in the pilot's situational awareness as well as performance has become a growing priority. We therefore require suitable tools for effective situational awareness measurement in simulation research rigs. This paper presents several insights into measuring situational awareness in cockpit systems research, and discusses in detail the rationale for a proposed test-battery approach that incorporates a variety of measurement techniques.
Author
Pilot Performance; Cockpits; Display Devices

19960023115 Armstrong Lab., Aircrew Training Research Div., Mesa, AZ United States
DEVELOPMENT OF CRITERION MEASURES OF SITUATION AWARENESS FOR USE IN OPERATIONAL FIGHTER SQUADRONS
Waag, Wayne L., Armstrong Lab., USA; Houck, Michael R., Dayton Univ. Research Inst., USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 8-1 - 8-8; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper describes the development of three Situation Awareness Rating Scales (SARS) that were used to measure pilot performance in an operational fighter environment. These instruments rated situation awareness (SA) from three perspectives: supervisors, peers, and self-report. SARS data were gathered from 239 mission-ready USAF F-15C pilots from 11 operational squadrons. Reliabilities of the SARS were quite high as measured by their internal consistency (.97 to . 99) and inter-rater agreement (.84). Correlations between the supervisory and peer SARS were strongly positive (.85 to .87), while correlations with the self-report SARS were positive, but smaller (.50 to .58). A composite SA score was developed from the supervisory and peer SARS using a principal components analysis. The resulting score was found to be highly related to previous flight experience and current flight qualification. A prediction equation derived from available background and experience factors accounted for 73% of its variance. Implications for use of the composite SA score as a criterion measure are discussed.
Author
Pilot Performance; Principal Components Analysis; Qualifications

19960023116 Illinois Univ. at Urbana-Champaign, Aviation Research Lab., Savoy, IL United States
SITUATION AWARENESS: IMPACT OF AUTOMATION AND DISPLAY TECHNOLOGY
Wickens, Christopher D., Illinois Univ. at Urbana-Champaign, USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, K2-1 - K2-13; In English; See also 19960023107; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In this paper we first offer two compatible definitions of situation awareness, present an information processing model of how it is maintained and lost, and discuss different techniques by which it is measured. Causes for the loss of situation awareness related to low visibility, dense airspace, free flight, and automation are briefly described, and then problems related to automation-induced situation awareness loss with the flight management system are discussed in detail. These problems are related to a poor mental model, high system complexity, removal of the pilot from the control loop, and inadequate displays. The next section of the paper focuses on display technology that has been used to support situation awareness of aviation hazards (traffic, weather, terrain). We discuss research issues related to electronic map scale, rotation, and dimensionality as these influence flight path guidance and hazard awareness. It is concluded that the more egocentric levels of these dimensions that do the best job of supporting flight guidance do not necessarily support situation awareness. The final section briefly discusses the less well researched area of task awareness.
Author
Display Devices; Tasks; Airspace; Free Flight; Flight Management Systems; Air Traffic

19960023119 Mooij and Associates, Oegstgeest, Netherlands
POINT-OF-GAZE MEASUREMENT IN AVIATION RESEARCH
Mooij, H. A., Mooij and Associates, Netherlands; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 12-1 - 12-9; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Traditional assessment methods (performance and subjective) may not be sufficient for the evaluation of man-machine systems, in which an appropriate level of situation awareness of the operator is of crucial importance. Eye Point-Of-Gaze (POG) and eye-blink measurement is one of the psychophysiological methods which may be helpful, as it can be continuously available without being intrusive to the operator's task. Eye point of gaze can provide data about where in the environment information is sought, as well as about the pattern of eye-scanning as evidenced in different situations. After a feasibility study, subsidised by the Netherlands' Agency for Aerospace Programmes (NIVR) in 1990, the European Space Agency (ESA) contracted Mooij & Associates in mid-1991 to develop a system capable of determining point of gaze in real time in digital form, for the evaluation of competing designs of user interfaces for controlling life-support systems as well as scientific experiments on board future space craft. The system was developed over a period of three years. A successful pilot experiment on a Graphical User Interface, also performed under ESA contract, concluded the initial development of the system at the end of 1993. The commercial version of the system is called Observer. The application of eye point-of-gaze data in aviation research will be set out in this report, followed by a description of the Observer system. In conclusion, an overview of Observer usage in two simulator programs is given.
Author
Eye (Anatomy); Graphical User Interface; Man Machine Systems

19960023120 Institute of Aviation Medicine, Prague, Czechoslovakia
SPEECH CHARACTERISTICS OF SITUATIONAL AWARENESS IN THE COURSE OF COPING WITH IN-FLIGHT EMERGENCIES
Sulc, J., Institute of Aviation Medicine, Czechoslovakia; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 13-1 - 13-11; In English; See also 19960023107; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A pilot, posed with an in-flight emergency works often under considerable pressure of strong emotions, resulting from an imperative threat to life. They can either destroy the situational awareness or leave it unaffected. Sonographic analysis allows to distinguish the emotional strain from behavioral breakdown with sufficient exactitude. While the information on emotional activation is mediated through the pitch variations, its impact on behaviour can be deduced from the temporal course of utterances. A relatively reliable sign of the loss of situational awareness in life threating situations is represented by the s.c. 'open scissors phenomenon', formed by an antagonistic movement of the pitch in relation to the speech rate. Its essence resides in the uncontrollable effect of asthenic emotions, leading to the enhancement of muscular stiffness, which increases the pitch and retards the speech rate. External appearance of disadaptation to the emotionally demanding situation conceivably correlates with the impaired quality of perceptual and cognitive processes, forming a basis for the in-flight situational awareness.
Author
Emotional Factors; Emergencies

19960023121 Sextant Avionique, Military Avionics Div., Saint Medard en Jalles, France
ENHANCING SPATIAL SITUATION AWARENESS IN HELMET MOUNTED DISPLAYS: AN APPROACH OF INTEREST AND LIMITATIONS THROUGH EXPERIMENTAL RESULTS *VISEUR DE CASQUE ET AMELIORATION DE LA PERCEPTION DE LA SITUATION SPATIALE: APPROACHE EXPERIMENTALE DE L'INTERET ET DES LIMITATIONS*
Leger, A., Sextant Avionique, France; Cursolle, J. P., Sextant Avionique, France; Leppert, F., Sextant Avionique, France; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 14-1 - 14-8; In French; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Maintaining spatial situation awareness in modern fighter aircraft is generally considered as a challenging issue. In regards of recent progress made in HUDs (Head Up Displays) formats, HMDs (Head Mounted Displays) format requirements appear far from being clearly

established. Encouraging results obtained by Osgood pointed out the potential interest of offboresight symbology for low level flying and ground attack missions. Such symbology could be of considerable interest to enhance in HMDs the usually poor quality imagery (I(sup 2), IR) used during night attack mission. A binocular night attack HMD has been developed by SEXTANT on an exploratory development launched by the French DGA in 1991. Part of this development was devoted to definition and implementation of a set of symbology to be used in conjunction with imagery during flight tests on a Mirage 2000 test-bed Aircraft at the Flight Test Center(Bretigny sur Orge). To achieve this goal, an experiment was carried out using the equipment developed for the flight tests. In a first experiment, short operational scenarios including low level navigation through mountains, runway attack and ground threats escape maneuvers were flown by experienced test and military pilots. Symbology and imagery were generated by a Silicon graphics 'Onyx' graphic workstation. Symbolic and sensor imagery presentations were slaved to head movement and the pilot was fully in control of aircraft maneuvers. A virtual immersion technique was used to compare conformal and non-conformal formats (attitude and trajectory). Results showed that most pilots recognized the potential interest of conformal symbology, but also that the format used ('bird cage') was too disorienting to be really useful. Though nonconformal symbology was seen as a rupture in the logic of presentation between HUD and HMD, it was also felt that, provided some improvements were made, it remained the most readily acceptable format.
Author
Helmet Mounted Displays; Fighter Aircraft; Head Movement; Mirage Aircraft; Aircraft Pilots; Aircraft Control

19960023124 Centre d'Etudes et de Recherches de Medecine Aerospatiale, Bretigny sur Orge, France
SITUATIONAL AWARENESS IN AERIAL COMBAT *LA CONSCIENCE DE LA SITUATION EN AERONAUTIQUE DE COMBAT*
Grau, J. Y., Centre d'Etudes et de Recherches de Medecine Aerospatiale, France; Menu, J. P., Centre d'Etudes et de Recherches de Medecine Aerospatiale, France; Amalberti, R., Centre d'Etudes et de Recherches de Medecine Aerospatiale, France; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 17-1 - 17-9; In French; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Situation awareness is a key psychological concept improving safety and performance in aircrafts. However, for a long time, any definition was commonly accepted. Now, works in cognitive psychology and ergonomics allow to propose new ways to describe features of situation awareness. Time pressure, risk taking, level of understanding, representation adjustment and anticipation are the elements in order to build dynamical models of situation awareness. These news aspects of situation awareness allow to identify different ergonomic recommendations to drive future interface design and to enhance situation awareness in combat aircrafts.
Author
Cognitive Psychology; Human Factors Engineering; Combat

19960023125 Armstrong Lab., Wright-Patterson AFB, OH United States
ATTENTIONAL CONTROL AND SITUATIONAL AWARENESS IN A COMPLEX AIR COMBAT SIMULATION
Vidulich, M. A., Armstrong Lab., USA; McCoy, A. L., Logicon Technical Services, Inc., USA; Crabtree, M. S., Logicon Technical Services, Inc., USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 18-1 - 18-5; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Situational awareness (SA) refers to a pilot's cognitive understanding of the mission situation. SA is complex and difficult to define because it involves a wide variety of cognitive processes. However, the present research hypothesized that one cognitive process, attentional control, would be key to understanding and enhancing pilot SA. to test this hypothesis a training procedure that was expected to improve an individual's attentional control was performed by one experimental group. Another group performed a placebo training procedure. Both groups received their training embedded within a larger program of performing complex air combat simulation missions. Performance and SA of the groups was measured both before and after the attentional control or placebo training. As expected, the group that received the attentional control training showed a greater improvement in performance than did the placebo control group. However, although the SA metrics appeared to be sensitive to an SA manipulation within the simulation, there did not appear to be any SA benefit associated with the attentional control training.
Author
Simulation; Combat

19960023126 Abertay Univ., Dundee, United Kingdom
AGENT BASED MULTIMEDIA DIALOGUES FOR REDUCED WORKLOAD AND INCREASED SITUATIONAL AWARENESS
Cook, Malcom James, Abertay Univ., UK; Elder, Leona, Abertay Univ., UK; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 19-1 - 19-9; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Situational awareness is the term used to describe the crew or pilot's awareness of operational conditions and contingencies and it has been implicated as a contributory factor in incidents and accidents in the air. Analysis of incidents reveals that pilots often fail to perceive a problem existed or that the significance of the cues with respect to the safety of the flight was overlooked. Presenting information in a suitable way can increase the probability that a specific event is noticed by the pilot. The method of presentation. however, can not ensure that the knowledge of the event is maintained or that its significance in situational terms is recognised. This paper examines evidence from the literature on vigilance tasks (sustained attention tasks) and dual task experiments which indicates that limits of short term memory, switching attention or time taken to access long-term memory can exacerbate the problem of maintaining situational awareness. Evidence from two experiments are discussed which indicate that the bottleneck for processing information in complex tasks may be related to attention switching and limits on short term (working memory).
Author
Workloads (Psychophysiology); Multimedia; Human Performance; Task Complexity; Alertness

19960023127 Armstrong Lab., Aircrew Training Research Div., Mesa, AZ United States
USE OF MULTISHIP SIMULATION AS A TOOL FOR MEASURING AND TRAINING SITUATION AWARENESS
Wang, Wayne L., Armstrong Lab., USA; Houck, Michael R., Dayton Univ. Research Inst., USA; Greschke, David A., Dayton Univ. Research Inst., USA; Raspotnik, William B., Dayton Univ. Research Inst., USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 20-1 - 20-8; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper presents the findings of a research investigation that explored the use of networked multiship simulation as a tool for measuring and training situation awareness (SA). The Division's research simulation facility was used which permitted two F-15s to fly against a suite of manned and unmanned adversaries in a realistic combat environment. Controller support was provided using a long-haul network linked to an AWACS simulation located at Brooks AFB, IX. A week-long evaluation syllabus was designed consisting of 9 sorties with 4 engagements per sortie. A building block approach was taken so that scenarios increased in difficulty over the week. Sixty-three mission ready F-15 pilots participated in the study. Performance ratings of SA were gathered using two trained observers. Additionally, mission outcome, network communications, video recordings, and eye movement data were gathered. As expected, SA, as measured in the simulation environment, was found to be positively correlated with ratings of SA previously obtained from the pilot's home squadron. Performance in the simulation was found to improve for identical engagements flown early and late in the syllabus. Positive opinions were expressed by study participants regarding the potential value of multiship simulation for training SA skills. Areas of greatest payoff

appear to be the training of flight resource management and decision-making skills. It was concluded that multiship simulation can be an effective tool for both measuring and training SA.
Author
Flight Management Systems; Simulation; Resources Management; Performance Prediction; Decision Making

19960023128 Defence and Civil Inst. of Environmental Medicine, North York, Ontario Canada
SITUATION AWARENESS AND WORKLOAD: BIRDS OF A FEATHER?
Hendy, K. C., Defence and Civil Inst. of Environmental Medicine, Canada; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 21-1 - 21-7; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In this paper it is argued that an hierarchical t information processing model, with a basis in s perceptual control theory, provides the necessary r framework for interpreting a large, unfocused empirical c literature on the topics of workload and situation(al) awareness (SA). The fundamental importance of situation awareness will emerge in considering the role of the mental model in providing the reference signal for a closed loop perceptual control system. It will be asserted that those aspects of the mental model generally covered by the SA rubric result from high level information processing activity that requires spare capacity to service. Increasing time pressure (workload) reduces the capacity available for this activity. An experiment in the application of a workload scale (NASA TLX) and a situation awareness] metric (SART) to a simulated air traffic control environment is cited. It will be shown that the situation awareness scale taps largely into the workload side of the equation rather than the SA side. Implications for the measurement of SA will be drawn.
Author
Workloads (Psychophysiology); Air Traffic Control; Data Processing

19960023129 Defence Research Agency, Farnborough, Human Factors Group., Hampshire, United Kingdom
WILL THE MISSION WORKLOAD PROFILE ALLOW EFFECTIVE SITUATIONAL AWARENESS?
Jensen, S. E., Defence Research Agency, Farnborough, UK; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 22-1 - 22-5; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper describes a video-based technique, C-SAW (pronounced 'see-saw'), for developing a time- and task-ordered mission profile of workload with a resolution of as little as 3 seconds real time and much less if used freeze-frame. The rating scale can be based on any uni-dimensional rating scale and can also be used with some multi-dimensional scales. When C-SAW is based on the Bedford scale, the result gives a good indication of the 'spare' attentional capacity which can be devoted to situational awareness. A proposed extension of the C-SAW approach to provide a specifically SA mission profile, based on SWAT, is described.
Author
Workloads (Psychophysiology); Effectiveness

19960023133 University Hospital, Dept. of Neurosurgery., Nottingham, United Kingdom
NEUROLOGICAL DIMENSIONS OF SITUATIONAL AWARENESS
Firth, J. L., University Hospital, UK; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 26-1 - 26-8; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The first problem in the Situational Awareness (SA) field is that of definition. The how, why, where and whens? Above all what is SA? Neurologically, SA is defined as the accurate, comprehensive, four dimensional appreciation of a situation at any one point in time. to be operationally effective SA has to be continuously up-rated, modified and developed throughout the time course of the operational epoch. The operational epoch is the significant period of time under consideration. This can be the duration of an engagement. a flight sector, a detail, a crisis, an operation, a detachment, a campaign, an electoral session or a historical era. SA is the first of the three essential, interlinked and inter-dependent components of aircrew operational ability and the foundation for the other two: appropriate decision and effective action.
Derived from text
Neurology; Flight Crews

19960053798 Armstrong Lab., Combined Stress Branch, Wright-Patterson AFB, OH United States
TASK PERFORMANCE THROUGHOUT PROLONGED HIGH G EXPOSURE
Chelette, Tamara L., Armstrong Lab., USA; Albery, William B., Armstrong Lab., USA; McCloskey, Kathy A., Armstrong Lab., USA; Goodyear, Charles D., Logicon Technical Services, Inc., USA; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Some ground-based research has investigated the loss of cognitive function in the extreme conditions of G-induced loss of consciousness (G-LOC), however, little is known about pilots' abilities to maintain cognitive performance throughout prolonged conscious exposure. Described herein is a centrifuge study in which human subjects repeatedly endured prolonged high-G
Derived from text
Acceleration Tolerance; Acceleration Stresses (Physiology); Exposure; Human Beings; Human Performance; Mental Performance

19960053806 NASA Johnson Space Center, Houston, TX United States
THE ROLE OF LINEAR ACCELERATION IN VISUAL-VESTIBULAR INTERACTIONS AND IMPLICATIONS IN AIRCRAFT OPERATIONS
Correia, Manning J., Texas Univ., USA; Luke, Brian L., Naval Aerospace Medical Research Lab., USA; McGrath, Braden J., Naval Aerospace Medical Research Lab., USA; Clark, John B., Naval Aerospace Medical Research Lab., USA; Rupert, Angus H., NASA Johnson Space Center, USA; Apr. 1996; 6p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

While considerable attention has been given to visual-vestibular interaction (VVI) during angular motion of the head as might occur during an aircraft spin, much less attention has been given to VVI during linear motion of the head. Such interaction might occur, for example, while viewing a stationary or moving display during vertical take-off and landing operations Research into linear VVI, particularly during prolonged periods of linear acceleration, has been hampered by the unavailability of a programmable translator capable of large excursions We collaborated with Otis Elevator Co. and used their research tower and elevator, whose motion could be digitally programmed, to vertically translate human subjects over a distance of 92.3 meters with a peak linear acceleration of 2 meters/sec(exp 2) During pulsatile or sinusoidal translation, the subjects viewed moving stripes (optokinetic stimulus) or a fixed point source (light emitting diode, led, display), respectively and it was generally found that. The direction of linear acceleration relative to the cardinal head axes and the direction of the slow component of optokinetic nystagmus (OKN) determined the extent of VVI during concomitant stripe motion and linear acceleration. Acceleration along the z head axis (A(sub z)) produced the largest VVI, particularly when the slow component of OKN was in the same direction as eye movements produced by the linear acceleration and Eye movements produced by linear acceleration are suppressed by viewing a fixed target at frequencies below 10 Hz But, above this frequency the suppression produced by VVI is removed. Finally, as demonstrated in non-human primates, vergence of the eyes appears to modulate the vertical eye movement response to linear acceleration in humans.
Derived from text
Acceleration; Aircraft Spin; Flight Operations; Human Beings; Nystagmus; Operations Research; Takeoff; Translating; Vertical Landing; Vestibules

19960053810 Dortmund Univ., Inst. fuer Arbeitsphysiologie, Germany
SPATIAL VISUO-MOTOR COMPATIBILITY IN A TRACKING TASK
Cavonius, C. R., Dortmund Univ., Germany; Ehrenstein, W. H., Dortmund Univ., Germany; Lewke, E., Dortmund Univ., Germany; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Two logically-related areas of study are discussed here: stimulus-response compatibility, which has to do with whether a signal and an operator's response to it are perceptually related - for example, whether both are located in similar parts of the operator's visual field and manual tracking, in which an operator uses a control device to follow a moving signal. In our experiments, subjects moved a stylus that was constrained to move along a straight path, to track a target that also moved in a straight line. Either the stylus track or the trajectory of the target could be rotated so that they were either parallel, or so that they were at an angle to one other. Performance, measured either by time-on-target or by the RMS error between the subject's track and the desired track, was best when the target and tracking movements were parallel and in phase, or nearly so; and worst when they in, or close to, counterphase. Earlier work has shown that when both the signal and the location of the response are stationary, performance is best when their positions are compatible. The present results show that this holds for moving targets as well.
Derived from text
Root-Mean-Square Errors; Visual Fields; Tracking (Position); Manual Control; Control Equipment

19960053812 Institute of Aviation Medicine, Fuerstenfeldbruck, Germany
THE FLIGHT ORIENTATION TRAINER (FOT) AS A MEANS OF EVALUATION AND VALIDATION OF PSYCHO-PHYSICAL LOAD ON FLYING PERSONNEL
Pongratz, H., Institute of Aviation Medicine, Germany; Amendt, R. O., Institute of Aviation Medicine, Germany; Lichtschlaeger, A., Institute of Aviation Medicine, Germany; Frank, P., Institute of Aviation Medicine, Germany; Vitz, H., Institute of Aviation Medicine, Germany; Scherb, W. H., Institute of Aviation Medicine, Germany; Heinz, G., Institute of Aviation Medicine, Germany; Apr. 1996; 6p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Spatial Disorientation (SD) is a dangerous threat in aviation. In order to improve its training programs for SD, the German Air Force (GAF) procured the so called Flight Orientation Trainer (FOT). The system is described and first experiences based on a troop trial in 1994 with 22 experienced pilots evaluating profiles are presented.
Derived from text
Aircraft Pilots; Disorientation; Training Devices

19960053813 Simon Fraser Univ., Brain Behaviour Lab., Burnaby, British Columbia Canada
MEG AND EEG RECORDED IN COMPLEX MULTITASKING ENVIRONMENTS FOR THE CLASSIFICATION OF HUMAN PERFORMANCE
Weinberg, H., Simon Fraser Univ., Canada; Cheyne, D., Simon Fraser Univ., Canada; Jantzen, K. J., Simon Fraser Univ., Canada; Apr. 1996; 6p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

One of the most important observations that William James made is that consciousness- the awareness of information - is comprised of continuous and successive processes, that consciousssness is a stream of events, and as such, the time domain of this stream must be understood. It is now clear that although the processing of information may be observed within some discrete interval of time, it necessarily depends on the previous processing of similar or identical input-memory always plays a role. Identical or similar input, to that previously experienced, does not necessarily mean that the processing of that input is similar or identical. Insofar as the brain is concerned the processing of each input includes not only the memory of previous inputs, but also those endogenous modifications imposed by the brain that are necessary for the final product, i.e., the conscious event, 'make sense', that is, to make the product consistent with the context in which it occurs, both historically and in the present. Memory is always a construction of the past, the present, and predictions of the future. Furthermore, it is now obvious that the brain of each person is an individual brain. The same brain may process the same input differently at different times, depending in part on previous experience, but also in part on its inherent capability do so - that is the inherent capability of the brain for variability - what characterises brains is not central tendency but variability.
Derived from text
Electroencephalography; Human Performance; Data Processing

19960053814 Defence and Civil Inst. of Environmental Medicine, North York, Ontario Canada
RESPONSE LATENCIES TO AIRCRAFT DETECTION AMONG NORAD SURVEILLANCE OPERATORS
Pigeau, R. A., Defence and Civil Inst. of Environmental Medicine, Canada; Angus, R. G., Defence and Civil Inst. of Environmental Medicine, Canada; ONeill, P., Operational Research and Analysis Establishment, Canada; Apr. 1996; 18p; In English; See also 19960053795; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

A function of North American Aerospace Defence (NORAD) in North Bay, Ontario is to identify all aircraft entering Canadian air space. The first step in performing this task is to detect visually the presence of aircraft from either radar or transponder information presented on display consoles. This challenging, real-world vigilance task was used in two experiments to investigate factors affecting detection latencies. Taken as a whole, the experiments revealed that 1) transponder tracks, with their unique symbology, were more easily detected than radar tracks; 2) performance varied as a function of geographic area of coverage; 3) the midnight shift was particularly sensitive to vigilance decrements; and 4) a 'vigilance decrement' effect can occur in a real world task, but this effect is not as strong as those reported in laboratory studies.
Derived from text
Aircraft Detection; Airspace; Alertness; Human Performance; Surveillance; Tasks

19960053816 Institute of Aviation Medicine, Oslo, Norway
AN ANALYSIS OF STRESS AND COPING FACTORS ON AIR CREW DURING EMERGENCY MEDICAL SERVICE (EMS) HELICOPTER OPERATIONS
Fonne, V. M., Institute of Aviation Medicine, Norway; Myhre, G., Institute of Aviation Medicine, Norway; Apr. 1996; 6p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Summary: The air ambulance service represents a field of operations where the crewmembers encounter situations which demand quick decisions and immediate action and where time limitations are frequent. Missions flown include diverse tasks such as inter - hospital transportation of patients as well as search and rescue operations. The operational stresses of this kind of service are plentifold and include both physical and psychological factors. Additional stressors include mission type, weather conditions and harsh terrain. Previous studies on stress and performance indicate that risk prone situations have a tendency to increase the crew's level of activation and will ultimately influence their performance. The purpose of the current study was to see whether one can observe differences in the crewmembers' physiological activation relative to mission type, crewmember's area of responsibility and individual psychological coping strategies and use of defense mechanisms. The initial study consisted of 31 male crewmembers from the Norwegian Air Ambulance Service distributed among helicopter pilots, medical doctors and rescue men. to assess physiological activation, plasma consentrations of cortisol were measured directly after mission completion as well as 24 hours later for controlling purposes. In addition, a psychological assessment was administered for an evaluation of general anxiety levels, coping strategies and defense mechanisms as well as subjective evaluations of the mission flown.
Derived from text
Ambulances; Medical Services; Emergencies; Helicopters; Patients; Physiology; Psychological Factors; Rescue Operations; Stress Analysis; Transportation

19960053817 Italian Air Force Pratica di Mare, Div. Aerea Studi Ricerche e Sperimentazioni, Rome, Italy
FATIGUE: OPERATIONAL AND CLINICAL ISSUES
Porcu, S., Italian Air Force Pratica di Mare, Italy; Bellatreccia, A., Italian Air Force Pratica di Mare, Italy; Mambro, G., Italian Air Force Pratica di Mare, Italy; Napolitani, I., Italian Air Force Pratica di Mare, Italy; Apr. 1996; 8p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Despite the great number of papers existing in the literature about the issue of fatigue - both in the clinical medicine and in the human factors field - it actually remains a controversial matter. This difficulty depends on the complexity of defining, recognizing. and measuring the phenomenon of fatigue and of evaluating its effects on performance Regarding operational contexts. fatigue may be seen as the

objective workload imposed by the task (input load), as the operator effort, or as the level of performance (work output). It is important, moreover, to divide the physical (central, peripheral-muscular) from the psychological fatigue. In general terms, physical exhaustion and performance impairments are not necessarily perceived as fatigue; psychological fatigue, instead, has a higher subjective component, a lower correlation with performance decrements, and is less dependent on the level of energy expenditure. Other distinctions may be done between acute, cumulative, and chronic fatigue. Several attempts have been made to model psychological fatigue and to explain the mechanisms involved in its generation and development. The activation theory, for instance which takes into account the level of arousal and performance considers fatigue as the result of functioning long time at an inadequate level. too high or too low. of information processing. A complex relationship actually exists among the level of arousal, objective measures of performance, the effort assessed using special probes (e.g.. cognitive evoked potentials during dual task. increasing complexity tasks), and subjective fatigue. The relationship between fatigue and performance is also complicated by the many interacting variables such as individual motivation and coping capability. In air operations. finally. fatigue may be related. in a reciprocal way. to 'automated' and 'controlled' tasks. with relevant effects on flight safety. Further efforts of the aeromedical community therefore should be directed to both identify early indicators of fatigue and to detect the different types (clinical syndrome or not) of fatigue. This paper is a review of the current knowledge about operational and clinical fatigue. taking into particular account a recent clinical entity. the chronic fatigue syndrome.
Derived from text
Aerospace Medicine; Clinical Medicine; Evoked Response (Psychophysiology); Exhaustion; Flight Safety; Human Factors Engineering; Muscular Fatigue; Task Complexity

19960053818 Italian Air Force Pratica di Mare, Rome, Italy
SLEEPINESS DURING AN ACURATE NIGHT SHIFT: NEUROPHYSIOLOGICAL CORRELATES AND EFFECTS ON PERFORMANCE
Porcu, S., Italian Air Force Pratica di Mare, Italy; Bellatreccia, A., Italian Air Force Pratica di Mare, Italy; Casagrande, M., Italian Air Force Pratica di Mare, Italy; Ferrara, M., Italian Air Force Pratica di Mare, Italy; Tricarico, A., Italian Air Force Medical Service HQ, Italy; Apr. 1996; 8p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Nocturnal sleepiness is a common complaint suffered from night shift workers. especially in condition of abrupt shift of the wake-sleep cycle. It is evident. therefore, that monitoring the presence of sleepiness and its effects on performance is of primary importance to the aeromedical community. In this study we evaluated the effects of a laboratory simulation of acute night shift on sleepiness. vigilance and performance, using Maintenance of Wakefullness Test. Multiple Sleep Latency Test and three pencil and paper tests: Digit Symbol Substitution Test Deux Barrage Test and Letter Cancellation Task. Results showed that the ability to maintain wakefulness and to perform visuoattentive tasks is substantially spared during the night. despite Multiple Sleep Latency Test and performance on Letter Cancellation Task reveal, respectively, increasing sleepiness and degrading performance on more complex and monotonous task.
Derived from text
Aerospace Medicine; Sleep; Neurophysiology; Simulation; Wakefulness

19960053819 Italian Air Force Pratica di Mare, Rome, Italy
PROSPECTIVE AND RETROSPECTIVE TIME ESTIMATION DURING AN ACUTE NIGHT SHIFT
DellErba, G., Italian Air Force Pratica di Mare, Italy; Bellatreccia, A., Italian Air Force Pratica di Mare, Italy; Tricarico, M., Italian Air Force Pratica di Mare, Italy; Porcu, S., Italian Air Force Pratica di Mare, Italy; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Prospective and retrospective time perception of six healthy subjects was analysed during an acute shift of the sleep-wake rhythm. Aim of the study was to verify possible detrimental effects of time of the night and side effects of temazepam, taken during the day, on internal time processing. within a double-blind balanced study. Our findings show that retrospective and prospective time perception are not significantly influenced by time of the night or by temazepam intake. However, there is a trend toward significance indicating that subjects underestimate time in the pure prospective condition the night following drug assumption.
Derived from text
Night; Perception

19960053820 Paris V Univ., Lab. d'Anthropologie Appliquee, France
FATIGUE IN AERONAUTICS: THE BASIS FOR A MODEL *LA FATIGUE EN AERONAUTIQUE: LES BASES D'UN MODELE*
Mollard, R., Paris V Univ., France; Cabon, P., Paris V Univ., France; Bougrine, S., Paris V Univ., France; Mourey, F., Paris V Univ., France; Coblentz, A., Paris V Univ., France; Apr. 1996; 10p; In French; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Although often used in current terminology, fatigue remains a badly defined concept in scientific works. The absence of a clear definition creates limits, since fatigue has many aspects, which are related to physiological, sensory, and mental. Physical fatigue and sensory fatigue are best understood at this time and can be evaluated by instrumentation. Mental fatigue presently remains a subjective concept, suggested by analogy with physical and sensory fatigue. It is characterized by a diminution of the operator's efficiency which translates into a more important effort to maintain his performance at an equivalent level. by contrast, the mechanisms of accumulation and recuperation remain poorly explored, in spite of the recognition of their importance, especially for stating recommendations concerning the length of missions and the resting of equipment. As a beginning for data in the literature and the present understanding, a rough study model applicable to aeronautics is proposed. This model especially takes a different account of the different components, such as environmental conditions, circadian rhythm, and the nature of the task. It is able to serve in support of experiments in the laboratory and in real situations.
Author
Circadian Rhythms; Physiology

19960053821 Centre d'Etudes et de Recherches de Medecine Aerospatiale, Bretigny sur Orge, France
SIMULATED SUSTAINED FLIGHT OPERATIONS AND EFFECTS ON VIGILANCE AND PERFORMANCE
Lagarde, D., Centre d'Etudes et de Recherches de Medecine Aerospatiale, France; Batejat, D., Centre d'Etudes et de Recherches de Medecine Aerospatiale, France; Mourareau, C., Centre d'Etudes et de Recherches de Medecine Aerospatiale, France; Vigneron, J. P., Centre d'Etudes et de Recherches de Medecine Aerospatiale, France; Walkowiak, P., Centre d'Etudes et de Recherches de Medecine Aerospatiale, France; Apr. 1996; 16p; In English; See also 19960053795; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

Many hours of work and waiting are necessary to prepare a flight operation. Sometimes, cancellation of mission and new programming can result for pilots in tiredness and drowsiness, especially some military operations as multiple, long range, carrier based, air combat missions (US A6 Intruder), maritim patrols (French Atlantics), observations (AWACS). The general schedule of this simulated sustained flight operation is: planning 1: 9 hours, rest period (without sleep): 4 hours, mission 1: 14 hours, rest period (with sleep): 6 hours, planning 2: 9 hours, rest period (without sleep): 4 hours, mission 2: 14 hours, night sleep recovery: 12 hours. to evaluate the level of vigilance and performance, questionnaires, mood scales, seven computer-administered performance tasks, a computeradministered sensitivity contrast threshold, and multiple sleep latency tests were repeatedly administered to the subjects throughout the experiment. An electroencephologram was also recorded during rest periods. Several physiological measures (heart rate, blood pressure, core temperature) were also obtained at regular intervals. After a training period eight healthy volunteers, military men were included in this study. The results show that the effects of this kind of sleep disturbance is limited. In fact, the most sensitive tasks were the memory search task (p less than 0.05) 2 and 4 letters, the tracking task (p less than 0.05) and the double task (p less than 0.05). The sleep latencies decreased more quickly during the second period of 27 hours sleep deprivation than during the first one. The same phenomenom was observed with the items : clumsiness, drowsiness and tiredness of the analog visual scale. No significant perturbation of temperature, heart rate and blood pressure rhythms was seen. This simulated sustained flight operation show a restricted but real perturbation of vigilance and efficiency. Recovery is observed after the diurnal nap, but it is limited in intensity and duration.

These data suggest that the nap is an interesting counter-measure for limited sleep deprivation but also that in case of repeated limited sleep deprivation or a more extensive sleep deprivation others counter-measures, like pharmacological substances, must be used.
Derived from text
Sleep Deprivation; Pharmacology; Physiology; Patrols; Military Operations; Mental Performance; Flight Operations

19960053825 Army Aeromedical Research Lab., Fort Rucker, AL United States
CURRENT NEUROLOGICAL PERFORMANCE ISSUES IN ARMY ROTARY-WING OPERATIONS
Crowley, John S., Army Aeromedical Research Lab., USA; Apr. 1996; 4p; In English; See also 19960053795; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

Modern rotary-wing military operations present unique challenges that demand optimal neurological performance of the aviator. Tactics unique to Army aviation can be particularly demanding, but many problems plague rotary-wing aviators in general. Helicopters classically require more attentional resources to control than do fixed wing aircraft; modern helicopters now present the aviator with complex computer systems to simultaneously master. Additionally, the living environment and flight environment inflict unique stresses on rotary-wing aviators--missions are mounted from unimproved field sites, frequently into oppressive thermal conditions that may persist throughout the mission. Nap-of-the-earth flying under night vision devices demands unerring cognitive and sensorimotor performance. Recent downsizing and changing tactics require the distant projection of force--rapid deployment of small and versatile fighting units--with the attendant hazards of sleep deprivation and circadian desynchronosis. It is likely that improving the quality of information presented to the aviator would reduce workload and the number of accidents due to disorientation. These enhancements could take the form of improved night vision systems, better instrument displays, 3D audio systems, etc. However, high priority should be given to developing and fielding guidance for aircrew work/rest cycles in the combat environment. Neurological performance in the face of operational stress would be best maintained via a customized crew endurance plan that competently addresses circadian rhythms, sustained operations, and operational medications.
Derived from text
Sensorimotor Performance; Circadian Rhythms; Combat; Disorientation; Display Devices; Flight Crews; Helicopters; Mental Performance; Military Operations; Rotary Wings; Sleep Deprivation; Workloads (Psychophysiology)

19960053826 Federal Aviation Administration, Human Factors Research Lab., Oklahoma City, OK United States
FATIGUE AND PERFORMANCE IN THE AIR TRAFFIC CONTROL ENVIRONMENT
DellaRocco, P. S., Federal Aviation Administration, USA; Cruz, C. E., Federal Aviation Administration, USA; Schroeder, D. J., Federal Aviation Administration, USA; Apr. 1996; 10p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Air traffic control (ATC) is a complex system in which controllers are faced with many of the human factors challenges posed to personnel in safety-related occupations. This paper focuses on the Civil Aeromedical Institute's (CAMI's) research on shift work-induced fatigue as one factor influencing controllers' performance. Many FAA controllers work relatively unique counterclockwise, rapidly rotating shift schedules. The research presented here was conducted in both laboratory and operational environments. Representative data from three studies are presented on characteristic sleep and performance patterns from controllers and noncontrollers working specific rapidly rotating schedules. Problem areas, coping strategy and countermeasures development, and implementation research are discussed.
Derived from text
Aerospace Medicine; Air Traffic Control; Controllers; Sleep; Fatigue (Biology)

19960053827 Naval Aerospace Medical Inst., Pensacola, FL United States
ENHANCING NEUROLOGICAL PERFORMANCE IN NAVAL AEROSPACE USS CARRIER GROUND AND SUPPORT OPERATIONS: PRACTICAL CHALLENGES
Barker, C. O., Naval Aerospace Medical Inst., USA; Hain, R. E., Naval Aerospace Medical Inst., USA; Apr. 1996; 10p; In English; See also 19960053795; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Flight operations aboard an aircraft carrier resemble operations at a busy, land based airport, only compressed into a small space. The flight operational environment is intense, prolonged, and very hazardous. This is especially true for the carrier's flight deck personnel who handle ground and support operations. This paper will discuss the major risk factors affecting flight deck personnel performance, the neurological implications, and practical challenges to enhancing performance. High workload, sustained operations, heat and cold stresses, wind and rain, neurosensory deficiencies, noise and vibration, as well as acute and chronic injury, emotional and interpersonal problems are all risk factors that can lead to neurological limitations affecting flight deck performance. Fatigue, lethargy, sleepiness. headaches, potential head, neck, and back injuries, as well as decreased visual acuity and hearing, peripheral neuropathies, decreased cognitive, motor, and coping functions are among the potential neurologic problems. These conditions will limit flight deck performance. These factors lead one to consider a number of efforts that could potentially enhance flight deck performance. Consideration of these presents a number of challenges. How can we better screen and periodically evaluate flight deck personnel for the 'right stuff'. Would a formal, more quantitative daily risk assessment and management program enhance overall flight deck performance? How should we address current education and training safety programs to enhance performance? How can we better handle morale issues that affect performance? Finally, potential applications of research findings to enhance neurologic performance in flight deck personnel present unique challenges. For example, should performance enhancing drugs be used, and if so, when and how?
Derived from text
Aircraft Carriers; Safety; Neurology; Lethargy; Ground Operational Support System; Emotional Factors

19970000596 Thomson Training and Simulation Ltd., Crawley, United Kingdom
SIMULATED VISUAL SCENES: WHICH ARE THE CRITICAL CUES?
McIntyre, H. M., Thomson Training and Simulation Ltd., UK; Roberts, M. E. C., Thomson Training and Simulation Ltd., UK; Apr. 1996; 8p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Research has shown that pilots can extract information from relatively impoverished visual scenes. However, performance of a variety of simulated flight tasks improves with greater scene complexity. Simulator visual systems cannot replicate the real world. Further, it is not possible to optimize visual system performance in all areas simultaneously. Some improvements in flight simulator visual cueing will come inevitably, as technology advances. Others present a research challenge, particularly where the likely effects of missing, contradictory or distorted information are not fully understood. These include: The luminance dynamic range of the display; this is far less than that encountered in reality. Relative luminances between objects cannot be maintained. Luminance variations with range will therefore be distorted. Maintaining accurate colour ratios at low luminances is also difficult. By careful mapping, detection ranges could be adjusted to be nominally accurate under specific conditions but not continuously accurate. The implications need to be considered carefully. The simulation of night scenes, with some illuminated areas may require the simultaneous mixing of 2 or 3 models in the same scene, creating unusual data base management demands. This requires further investigation. Distance judgments may be observed to be inaccurate in the simulator. to prevent this leading to degraded simulator performance and deficiencies in training it may be possible to compensate for the absence of some cues by enhancing the effect of others. Further

investigation is required to establish whether such compensation is truly possible, to what degree it enhances simulator effectiveness and to identify associated costs.
Author
Visual Discrimination; Visual Perception; Pilots (Personnel); Visual Stimuli; Cues; Flight Crews; Flight Simulators; Luminance; Flight Simulation

19970000597 Cranfield Univ., Dept. of Applied Psychology, Bedford, United Kingdom
VISUAL SCENES FOR BATTLEFIELD HELICOPTER OPERATIONS: EVALUATION OF REQUIREMENTS AND HOW TO SPECIFY THEM
Deighton, C. D. B., Cranfield Univ., UK; Woodfield, Alan A., Woodfield Aviation Research, UK; Apr. 1996; 12p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The structured specification and evaluation of simulated visual scenes for training pilots in tasks such as Battlefield Helicopter operations is required to ensure that cost-effective flight simulator training is being achieved. Historically this has been a difficult process because of a lack of consistent and prioritized descriptions of different visual flight activities within the intended training missions; limited evaluations of the contributions and relative importance of different scene features within appropriate operational scenes; and a lack of any structured way of collating and presenting such information to those who specify and design visual scene databases for flight training simulators. A research program funded by the UK Defence Research Agency was conducted in collaboration with Cranfield University, UK to address these challenges. Specific aims were to identify and prioritize visual flight activities in the context of a battlefield nap-of-the-earth (NoE) attack mission; to determine the relative importance of visual scene components (e.g. woods, farm buildings, roads, livestock) to the achievement of visual flight activities: and to assess the impact of removing or adding information to the scene upon the achievement of visual flight activities in a mission simulator. The purpose of the paper is twofold: firstly to describe the human factors procedures and techniques used to address these aims and secondly to describe the proposed structure of a computer based relational database to integrate the results of the program. Selected findings from the study are used to highlight the structure of the database.
Author
Visual Flight; Nap-Of-The-Earth Navigation; Helicopters; Flight Training; Flight Simulators; Combat; Visual Discrimination

19970000598 Aeronautical Systems Div., Training Systems Product Group, Wright-Patterson AFB, OH United States
VISUAL SYSTEM OPERATIONAL EVALUATION
Brown, James E., Aeronautical Systems Div., USA; Poe, Don R., Aeronautical Systems Div., USA; Lincourt, Timothy J., Aeronautical Systems Div., USA; Leos, Melissa J., Aeronautical Systems Div., USA; Apr. 1996; 12p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents the results of an operational evaluation of the training effectiveness of three different visual technologies. Purpose of the program was to determine (1) trainability of low altitude tasks on available visual display technology; (2) demonstrate current visual simulation technology to users; (3) get feedback from those users to help define future visual requirements; and (4) provide information and data to support future simulation acquisition decisions. Three visual simulation display technologies at three different sites were evaluated: (1) a dome display with head tracked area-of-interest, (2) a rear-projection display, and (3) a fiber optic helmet mounted display. A team of highly experienced F-16C and F-16E instructor pilots evaluated each of the three display technologies. Three evaluation missions were flown by each pilot. At the completion of each evaluation mission, extensive questionnaires were completed and de-briefings were conducted to rate the training capability of the visual system for each task. Results are presented for each of the three display systems evaluated. The results are expressed in terms of tasks that were rated trainable and those tasks that were not trainable in the system.
Author
Display Devices; Training Evaluation; Helmet Mounted Displays; Flight Simulation; Visual Acuity; Visual Perception

19970000599 NASA Ames Research Center, Moffett Field, CA United States
YAW MOTION CUES IN HELICOPTER SIMULATION
Schroeder, Jeffrey A., NASA Ames Research Center, USA; Johnson, Walter W., NASA Ames Research Center, USA; Apr. 1996; 16p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A piloted simulation that examined the effects of yaw motion cues on pilot-vehicle performance, pilot workload, and pilot motion perception was conducted on the NASA Ames Vertical Motion Simulator. The vehicle model that was used represented an AH-64 helicopter. Three tasks were performed in which only combinations of vehicle yaw and vertical displacement were allowed. The commands issued to the motion platform were modified to present the following four motion configurations for a pilot located forward of the center of rotation: (1) only the linear translations, (2) only the angular rotation, (3) both the linear translations and the angular rotation, and (4) no motion. The objective data indicated that pilot-vehicle performance was reduced and the necessary control activity increased when linear motion was removed; however, the lack of angular rotation did not result in a measured degradation for almost all cases. Also, pilots provided subjective assessments of their compensation required, the motion fidelity, and their judgment of whether or not linear or rotational cockpit motion was present. Ratings of compensation and fidelity were affected only by linear acceleration, and the rotational motion had no significant impact. Also, when only linear motion was present, pilots typically reported the presence of rotation. Thus, linear acceleration cues, not yaw rotational cues, appear necessary to simulate hovering flight.
Author
Yawing Moments; Cues; AH-64 Helicopter; Motion Perception; Motion Simulation; Vertical Motion Simulators; Flight Simulation

19970000618 Thomson Training and Simulation Ltd., Crawley, United Kingdom
ISSUES IN THE DEVELOPMENT OF TRAINING ANALYSIS METHODOLOGIES
Simpson, Terry, Thomson Training and Simulation Ltd., UK; Apr. 1996; 8p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Training analysis is a topic that is often talked about and less often carried out. Various methods have been proposed in the past, but many of these have been too complex and too prescriptive for practical purposes. Major system procurements on cost-plus contracts in the past may have justified detailed methodologies, but the majority of modern training analysis is required on small fixed price contracts. The training analyst is often solely responsible for the work, or working in a small group of 2 or 3. Consequently, the analyst has to use techniques that can be easily applied and be flexible enough to carry over from one contract to another. This paper describes a range of issues that affect training analysis and presents a simple methodology that can be easily adopted by analysts and applied to commercial situations.
Author
Training Analysis; Education

19970000619 Technische Univ., Inst. of Flight Guidance and Control, Brunswick, Germany
DELAYED PILOT RESPONSE IN WINDSHEAR
Schaenzer, G., Technische Univ., Germany; Krueger, J., Technische Univ., Germany; Apr. 1996; 10p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Windshear can cause fatal accidents. to pass windshear situations safely, the automatic flight control should be employed. This advice is in contrast to an FM recommendation to switch off the autopilot in a windshear and to perform a go-around procedure. With conventional instrumentation and manual approach extremely large time delays up to 40 seconds could be identified. It is still unclear what the psychological reasons for this delay are. There are some indications that the human being reacts like a band pass filter. With proper display information a thrust command director can be realized that may force the pilot to react correctly and safely in windshear situations.
Author
Wind Shear; Time Lag; Delay; Automatic Pilots

19970012387 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
SELECTION AND TRAINING ADVANCES IN AVIATION *LES PROGRES REALISES EN SELECTION ET FORMATION DES PERSONNELS NAVIGANTS*
Selection and Training Advances in Aviation; Nov. 1996; 286p; In English; In French; Aerospace Medical Panel Symposium, May 1996, Prague, Czechoslovakia; See also 19970012388 through 19970012416
Report No.(s): AGARD-CP-588; ISBN 92-836-0035-5; Copyright Waived; Avail: CASI; A13, Hardcopy; A03, Microfiche

These proceedings include the Technical Evaluation Report, Keynote Address, Paper Presentations, and Poster Display Presentations of the Symposium sponsored by the AGARD Aerospace Medical Panel and held at the Ministry of Defence, Prague, Czech Republic, 28-31 May 1996. Over the last few decades, aircraft and air operations have become more sophisticated. Technological innovations have resulted in higher-performance, more-complex weapons systems. That increased performance and complexity have placed greater physical and psychological demands upon aviators. Refinement of materiel and improvements in selection and training technologies have enabled aviator selection and training processes to evolve. The purpose of this Symposium was to unite military and civilian experts in the field of selection and training. The papers addressed aviator selection and training, including: human abilities measurement; anthropometric accommodation; gender differences; crew resource management; flight simulators; spatial disorientation; cost effectiveness; centrifuge training; and g-tolerance. These proceedings will be of interest to those concerned with selection criteria, progression in selection techniques, training processes, physiological training, and facility advances in aviation. Interaction of medical, physiological, cognitive, psychomotor, and personality factors in the selection process are highlighted.
Derived from text
Research and Development; Flight Operations; Aircraft Pilots; Aerospace Medicine

19970012388 Armstrong Lab., Aircrew Selection Research Branch, Brooks AFB, TX United States
ADVANCES IN USAF PILOT SELECTION
Weeks, Joseph L., Armstrong Lab., USA; Zelenski, Warren E., Armstrong Lab., USA; Carretta, Thomas R., Armstrong Lab., USA; Selection and Training Advances in Aviation; Nov. 1996; 12p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Although modern aviation technology provides tremendous advantages, there is concern that complex cockpit systems may introduce psychological problems for aircrew. This concern is particularly relevant for pilot training. Such problems could result in loss of life and increased training costs. For trainer aircraft currently used in USA Air Force (USAF) Undergraduate Pilot Training (UPT), training costs are high. The cost of an eliminee from pilot training can be as much as $350,000 depending on when elimination occurs in the training process. In the past, pilot selection systems have helped identify those individuals most capable of successful performance in UPT. In the future, pilot selection systems can be developed to help minimize any adverse training impacts of modern aviation technology. Analyses of new cockpit systems can reveal the human capabilities required for successful training performance. In addition, advances in the measurement of human abilities allow us to fine tune pilot selection systems to identify candidates having the ability profiles required for training with complex modern aircraft. Use of candidate ability information by pilot selection boards results in improved person job match, higher quality trainees, lower training wastage and ultimately, improved air combat readiness.
Author
Pilot Training; Pilot Selection; Psychological Factors; Human Performance

19970012390 Armstrong Lab., Brooks AFB, TX United States
CHARACTERISTICS OF FEMALE AND MALE USAF PILOTS: SELECTION AND TRAINING IMPLICATIONS
King, R. E., Armstrong Lab., USA; McGlohn, S. E., Armstrong Lab., USA; Selection and Training Advances in Aviation; Nov. 1996; 4p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The determination of psychological fitness to fly is complicated, particularly when attempting to extrapolate what little we know about male aviators to women. New training needs, for both women and men, may arise as the number of a country's female aviators increases. The large numbers of aviators in the USA Air Force (USAF) enable it to do research that may be instructive to other, smaller, air forces.
Author
Aircraft Pilots; Pilot Selection; Pilot Training

19970012391 Institute of Aviation Medicine, Prague, Czechoslovakia
THE ANALYSIS OF SAFETY INDICATORS IN THE AVIATORS' TRAINING
Kolouch, Jan, Institute of Aviation Medicine, Czechoslovakia; Selection and Training Advances in Aviation; Nov. 1996; 4p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The prevention of aviation accidents used to be, in the former Czechoslovak Air Force in the centre of Commands attention. A system access to solving this problem area achieved the lowest losses of pilots and planes in the 1970s. Within the framework of validation of the methods, used in selection and training procedures, the analysis of the level in actual combat flight training was carried out in a fighter group (150 pilots) in the last years. The achieved results confirmed the reliability of psychophysiological examination with cadets and the prognostic validity of the criteria used in the selection processes. With the 90% level of significance the hypothesis of personality predisposition to errors in flying by the individuals having a lower level of cognitive functions development and with the manifestation of the emotional irritability has been confirmed. The characteristics of test batteries and the relevant criteria used for the expertise together with account of incidents and accidents will be dealt with.
Author
Aircraft Pilots; Pilot Selection; Training Analysis; Psychophysiology; Safety; Prevention; Human Behavior; Flight Training; Errors

19970012392 Canadian Forces Personnel Unit, North York, Ontario Canada
THE CANADIAN AUTOMATED PILOT SELECTION SYSTEM (CAPSS): VALIDATION AND CROSS VALIDATION RESULTS
Adams-Roy, J. E., Canadian Forces Personnel Unit, Canada; Selection and Training Advances in Aviation; Nov. 1996; 2p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The current pilot selection system used by the Canadian Forces to assess pilot applicants incorporates paper and pencil ability tests, and an evaluation of psychomotor skill measured on a general aviation trainer. Each measure is weighted differently and the scores are then combined together to give candidates a final Pilot Stanine (PS). Although able to satisfactorily select candidates for pilot training, the increasing complexity of modern aircraft and the high costs associated with training have led the CF to adopt a new selection measure, the Canadian Automated Pilot Selection System (CAPSS) which will be implemented in January 1997.
Derived from text
Pilot Training; Pilot Selection; Training Devices; Psychomotor Performance; Psychological Tests

19970012393 Army of the Czech Republic, Expert Lab of the Inspector of the Air Force and Air Defence, Prague, Czechoslovakia
ANALYSIS OF PSYCHOMOTOR PERFORMANCE OF FIGHTER PILOTS DURING FLIGHT
Solcova, I., Army of the Czech Republic, Czechoslovakia; Sykora, J., Danwell, Inc., Czech Republic; Dvorak, J., Army of the Czech Republic, Czechoslovakia; Gadourek, P., GETA, Czech Republic; Selection and Training Advances in Aviation; Nov. 1996; 4p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Eighteen healthy males with different degrees of flight experience were tested during piloting an L-29 jet-trainer plane during 54 standardized aerobatic flights. In 13 pilots up to four successive aerobatic flights were realized, separated by half an hour intervals on the ground. The ranks of the expert evaluated in-flight psychomotor performances during standardized aerobatic flights and of the values of the individual total flight time hours were highly significantly correlated ($r = 0.86$). Computer based analysis of the quality of performance of flight

maneuvers showed that the pattern of piloting the plane was highly individual. Nevertheless, the coefficient of reliability of the courses of repeated flights of experienced pilots (normalized as to the duration of each maneuver and the maximal G-level reached) equaled to r = 0.97. Evidently, the individual pattern of flying is a stable characteristic of the performance of experienced pilots. It is something like their signature. Results of analysis were compared with other indices of pilot's performance under the influence of hypergravity.
Author
Aircraft Pilots; Pilot Performance; Pilot Training; Psychomotor Performance; Flight Tests

19970012394 Royal Air Force, Directorate of Recruiting and Selection, Cranwell, United Kingdom
CURRENT STATUS AND FUTURE DEVELOPMENTS OF RAF AIRCREW SELECTION
Bailey, M., Royal Air Force, UK; Woodhead, R., Royal Air Force, UK; Selection and Training Advances in Aviation; Nov. 1996; 10p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper summarizes the current status of the RAF aircrew aptitude selection process against work conducted during the previous decade and identifies a number of problems and possible future directions. An ability domain structure was explored and incorporated into the current test development policy. This concept was further expanded to develop a validation model which uses wider and more detailed criteria to provide a more accurate and informative estimate of selection measure validity.
Author
Aptitude; Flight Crews; Pilot Training; Pilot Selection; Pilot Performance

19970012395 German Air Force, Institute of Aviation Medicine, Koenigsbrueck, Germany
SELECTION OF FUTURE FIGHTER PILOTS
Welsch, H., German Air Force, Germany; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A new concept in selection of the future fighter pilot generation was created in 1992 by the Surgeon General of the German Air Force. In addition to the basic medical, physical, and psychological examination at the German Air Force Institute of Aviation Medicine (GAFIAM) at Fuerstenfeldbruck the natural, unprotected, relaxed G-tolerance of the healthy young men, which have passed the examination successfully, was determinated in the human centrifuge on a voluntary basis. In connection with the consideration of the medical and psychosomatic findings just before and during the determination of the G-tolerance the individuals were scored. Based on this score three categories were established as recommendation for a possible pilot career of the candidates in high performance aircraft. The mean age of the 304 pilot candidates was 20 + 1.6 years. They reached a relaxed, unprotected G-tolerance of 4.6 + 0.5 gz. The classification of this evaluation, with regard of the heart rate and mental stress reaction signs, of the last 129 of these 304 candidates, was: 45 especially qualified, 75 qualified, and 9 less qualified. The score of the first 22 re-evaluated candidates during the G-training course in Koenigsbrueck about two years later showed no major change in the score in comparison with the first screening results. These first findings in the comparison of the results of the early phase evaluation and the G-tolerance during the G-training course allows to suppose, that the selection of pilots, added by the human centrifuge screening methods, offer a new chance to make the screening more effective and reach both: satisfy the candidates, and the German Air Force.
Author
Physical Examinations; Stress (Psychology); Aerospace Medicine; Pilot Performance; Pilot Selection; Pilot Training

19970012396 Royal Air Force, Headquarters Strike Command, High Wycombe, United Kingdom
FLYING TRAINING - PAST ACHIEVEMENTS AND FUTURE CHALLENGES
Spiller, N. B., Royal Air Force, UK; Selection and Training Advances in Aviation; Nov. 1996; 12p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The cost of modern combat aircraft requires that they are operated safely in peacetime. Equally, the nature of air operations demands their aggressive operation in war. The challenge is to recruit people who can satisfy these 2 differing requirements. Moreover, this has to be done against a background of the difficult recruiting, manning and experience issues facing many modern Air Forces. The challenge is to identify and train effectively the correct number and balance of fighter pilots for the 21st Century.
Author
Fighter Aircraft; Pilot Performance; Pilot Training

19970012399 Armstrong Lab., Brooks AFB, TX United States
THE USAF'S ENHANCED FLIGHT SCREENING PROGRAM: PSYCHOLOGICAL ASSESSMENT OF UNDERGRADUATE PILOT TRAINING CANDIDATES
Callister, J. D., Armstrong Lab., USA; Retzlaff, P. D., University of Northern Colorado, USA; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Enhanced Flight Screening (EFS) program consists of both flying and medical screening. This paper will focus on the psychological assessment techniques of the EFS program. Measures of intelligence and cognitive abilities are included. Undergraduate Pilot Training candidates are required to take the Multidimensional Aptitude Battery, an intelligence test, and the CogScreen-Aeromedical Edition, a measure of cognitive skills. Over 1,500 candidates have completed the EFS program. Ninety-four percent of the candidates have consented to allow their data to be used for research. Intelligence testing scores are well above average. Pilot candidates differed from commercial pilots on several cognitive measures. Commercial pilots were more accurate on measures of math abilities, while pilot candidates were more accurate on measures of memory. Commercial pilots were more efficient with most cognitive tasks, except that pilot candidates were more efficient with dual and divided tasks. Commercial pilots made more perseverative errors, while pilot candidates made more impulsive errors. Computer administration of psychological tests makes it possible to efficiently collect clinically relevant data on all candidates. Collection of this data for each candidate will improve the quality of medical waiver recommendations through the use of idiographic data. Collectively, this process provides an infrastructure for productive longitudinal selection research.
Author
Pilot Training; Psychological Tests; Intelligence; Mental Performance; Aptitude; Abilities

19970012400 Air Force Inst. of Aviation Medicine, Fuerstenfeldbruck, Germany
SIMULATOR BASED TEST SYSTEMS AS A MEASURE TO IMPROVE THE PROGNOSTIC VALUE OF AIRCREW SELECTION
Gress, W., Air Force Inst. of Aviation Medicine, Germany; Willkomm, B., Air Force Inst. of Aviation Medicine, Germany; Selection and Training Advances in Aviation; Nov. 1996; 4p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

A simulator based aviation psychological test system in use in the German Air Force called the 'FPS 80' which is the German abbreviation of 'Aviation Psychological Selection System 80' is described to point out the advantages and the disadvantages of simulator based tests in comparison to classical psychological tests. While classical psychological tests try to examine single abilities simulator based test systems measure a student pilot's abilities in a complex test situation similar to a real training situation. The role of the FPS 80 within the sequential selection strategy of the GAF will be described in the study. The results of a study based on the data of over 300 student pilots of the years 1994 and 1995 show that the prognostic value of the whole selection system could be increased considerably by using simulator based tests. The prognostic value of the selection process becomes evident in the correlations of psychological data and the results of academic training and of flight training in the flying screening. A comparison of the prognostic value with and without the use of the FPS 80 shows that the correlation of the whole selection process could be increased from .3 to over .5. The results also show that the prognostic value of the FPS 80 itself could be increased by adding data from a

psychological observation of behaviour to the computer generated test scores. As a conclusion the advantages and the limits of such a simulator based test system are pointed out.
Author
Flight Training; Flight Crews; Pilot Selection; Pilot Training

19970012401 Armstrong Lab., Brooks AFB, TX United States
SELECTION OF SPECIAL DUTY AVIATORS: COGNITIVE AND PERSONALITY FINDINGS
Patterson, John C., Armstrong Lab., USA; Schofield, Gary L., Armstrong Lab., USA; Howe, Brian, Armstrong Lab., USA; Bonney, Jacqueline D., Armstrong Lab., USA; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper will describe a selection program for special duty aviators. Different from other selection programs, this program selects already trained pilots as well as other non trained crewmembers such as loadmasters and flight engineers for special aviation duty. These aviators are selected to fly for the U.S. Air Force Special Operations Command (AFSOC) in airframes such as the MH 53 helicopter.
Derived from text
Aircraft Pilots; Personality; Pilot Selection; Pilot Training; Pilot Performance

19970012402 Armstrong Lab., Aircrew Training Research Div., Mesa, AZ United States
R AND D ADVANCES IN USAF PILOT TRAINING
Carroll, Lynn A., Armstrong Lab., USA; Andrews, Dee H., Armstrong Lab., USA; Selection and Training Advances in Aviation; Nov. 1996; 10p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Recent advances in aircrew training methods and technologies now allow the Air Force to conceptualize training as the peacetime manifestation of war. That is, ground-based pilot training can now move beyond simply training procedural skills to training wartime mission skills on a much more frequent basis than past training range training has allowed. We discuss R&D advances in three key areas that will truly allow the Air Force to train as it intends to fight. These three areas are 'Warfighter Training Behavioral Research', "Distributed Mission Training Engineering Development', and 'Night Vision Device Training R&D'. Under each of these three main categories of R&D we discuss specific advances made in our laboratory. We also discuss future directions that we believe aircrew R&D should advance in order to provide synthetic training environments that will allow the full measure of warfighting skills to be trained.
Author
Pilot Training; Mission Planning; Flight Crews

19970012403 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Institute of Aerospace Medicine, Hamburg, Germany
TRAINING OF AIRCREW DECISION MAKING
Hormann, Hans-Jurgen, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Aircrew decision making is one central element of the CRM-training course for cockpit crews which was developed recently by the DLR-Department of Aviation and Space Psychology in cooperation with Lufthansa German Airlines and Condor. Examples of the course contents and methods are illustrated. As a framework for the training units of aircrew decision making the FOR-DEC model is proposed. FOR-DEC is an acronym which stands for six different phases of the decision making process: Facts, Options, Risks & Benefits, Decision, Execution and Check. The paper describes how this model is integrated into the training units on team problem solving and decision making. First evaluation results of the course are shown which are based on the seminar critiques of 750 participants. These feedbacks are very positive in regard to the overall relevance of the course contents and methods. However, they also indicate the importance of authentic in-house scenarios for the effectiveness of the seminar processes.
Author
Aviation Psychology; Decision Making; Flight Crews; Problem Solving; Pilot Performance; Pilot Training; Pilot Selection

19970012405 Abertay Univ., Dundee, United Kingdom
UNDERSTANDING THE REQUIREMENT: A REVIEW OF COMMON PROBLEMS IN TRAINING, SELECTION AND DESIGN
Cook, Malcolm, Abertay Univ., UK; Ward, George, ESE Associates, UK; Selection and Training Advances in Aviation; Nov. 1996; 20p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A recent review of pilot selection procedures cast doubt upon the predictive capabilities of pilot selection batteries to identify the specific qualities that identify good pilots in the initial stages of the selection process. In other contributions to the same text many authors poured scorn on the relatively poor quality of psychological tools in selecting out ineffective pilots or in evaluating pilot's performance with laboratory based tasks. Three conclusions can logically be drawn from this work, presentations at the AGARD Spring Symposium in 1995 on Situational Awareness and other papers in the open literature. Either the tests applied in selection of pilots are poor in themselves, the understanding of the cognitive demands placed on pilots is poor or the both the tests, understanding of tasks and their application are suspect. Although there have been reports which suggest that predictive validity may, indeed, be declining in tests used in pilot selection the problem underpinning the ineffective selection may be inadequate quantitative and qualitative descriptions of the pilot's tasks.
Derived from text
Pilot Selection; Predictions; Pilot Performance

19970012406 Defence Research Agency, Systems Integration Dept., Farnborough, United Kingdom
PERFORMANCE AND WORKLOAD MEASUREMENT IN SIMULATION-BASED TRAINING
Newman, P., Defence Research Agency, UK; Farmer, E. W., Defence Research Agency, UK; Belyavin, A. J., Royal Air Force, UK; Selection and Training Advances in Aviation; Nov. 1996; 12p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Experiments were conducted to determine the utility of measures of skill acquisition in simulator-based training. Objective performance measures were supplemented by workload measures, to permit assessment of possible changes in demand for mental resources during task learning. In the two experiments reported here, performance measures of speed, accuracy and continuous manual control were found to satisfy criteria such as sensitivity to practice and to individual differences. Several workload measures, particularly the DRA Workload Scales, also provided useful and reliable information. However, provision of performance feedback to the subject during training sessions had a limited effect on skill acquisition. On completion of this series of experiments, standardised batteries of measures will be specified for application to training.
Author
Workloads (Psychophysiology); Training Simulators; Pilot Performance; Pilot Plants; Pilot Training

19970012407 German Air Force, Institute of Aviation Medicine, Koenigsbrueck, Germany
TRAINING OF FUTURE FIGHTER PILOTS
Welsch, H., German Air Force, Germany; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Before starting the pilot school in USA the young, G-inexperienced student pilots were trained on the human centrifuge (HC) at Koenigsbrueck near Dresden, Saxony. This G-training is an integrated part of their one-week basic physiological training course. The objective of this course is, that the students become familiar with the G-environment safely. In the beginning of the G-training the student pilots were exposed to the same G-profiles as the pilot candidates. On the second day they were trained in muscle straining and anti-G-breathing technique during moderate HC runs with and without anti-G-equipment. Then they were able to use these techniques in the HC during active profiles. The result and effectiveness of this training will be documented by a special qualification profile. This qualification profile consists of the same passive linear profile as on the first day. The student pilots don't wear anti-G-trousers. During the increasing G-load they should first stay relaxed, until they reach their 50% peripheral light loss (1. PLL). In this moment they activate their muscle straining, until they reach the second time PLL (2.PLL). Now they start the anti-

G-breathing technique until they reach their individual maximum active G-tolerance (3. PLL). The results of the G-training of the first 198 student pilots, mean age 22.9 + 1.7 years, mean height 180.3 + 5.5 cm, body mass 76.8 i 7.9 kg indicate, that that the muscular straining manoeuvre will increase the G-tolerance by about 1.0 gz, and the additional breathing manoeuvre will increase the G-tolerance by another 1.5 gz, totally 2.5 gz even under artificial, not operational conditions.
Author
Pilot Training; Qualifications; Physiology

19970012408 Canadian Air Command Headquarters, Aviation Physiology Section, Westwin, Manitoba Canada
AVIATION PHYSIOLOGY TRAINING IN THE 21ST CENTURY
Glass, K. C., Canadian Air Command Headquarters, Canada; Wilkinson, M. O., Army Special Warfare Center, USA; Selection and Training Advances in Aviation; Nov. 1996; 8p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Canadian Aeromedical Training Program has recently undergone significant changes. Other countries are also reviewing their aeromedical training programs and looking for new or different ways to provide the necessary academic training at the correct frequency using the best methods possible. The U.S. Navy has completed an extensive review of its program and is currently exploring the possibility of providing continuation aeromedical training in conjunction with flight simulator training. The Royal Australian Air Force already uses an innovative approach to provide night vision training that may be appropriate for use by other countries. It seems inevitable that aeromedical training programs will continue to change in the future. to ensure that these changes are appropriate and that they improve flight safety, it is essential that measurement tools be developed to assess current programs and to determine what changes should be made. Due to current and potential changes in aeromedical training programs, it would seem appropriate, in the interests of international standardization of aeromedical training in the future, to revise the terms of STANAG 3114.
Author
Training Simulators; Aerospace Medicine; Flight Safety; Night Vision

19970012409 Defence and Civil Inst. of Environmental Medicine, School of Operational Medicine, North York, Ontario Canada
CENTRIFUGE TRAINING IN THE CANADIAN FORCES: A REVIEW OF THE FIRST SIX YEARS' EXPERIENCE
Bateman, William A., Defence and Civil Inst. of Environmental Medicine, Canada; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In the late 1980s, the Canadian Forces developed and implemented a centrifuge training program intended to enhance the preparedness of its aircrew for the G-stress of modern fighter aircraft. In the six years from 15 June 1989 until 25 May 1995, 439 personnel attended 97 serials of this one-day course. Although a rigid performance standard was not set, aircrew from various CF pilot populations completed the target profile with success rates ranging from 61-83% (the more experienced fighter pilot groups doing better). The lessons learned in this first six years have paved the way towards a new program, with broader mandatory target population, provisions for refresher training, and G-tolerance improvement for those unable to complete the target profile.
Author
Centrifuges; Aircraft Pilots; Flight Crews; Experience

19970012412 Institut de Medicine Aerospatiale Armee, Dept. Sciences Cognitives et Ergonomie, Bretigny sur Orge, France
AT THE HEART OF SIMULATOR FORMATION: THE TRANSFER OF TRAINING *AU COEUR DE LA FORMATION SUR SIMULATEUR: LE TRANSFERT D'ENTRAINEMENT*
Grau, J. Y., Institut de Medicine Aerospatiale Armee, France; Doireau, P., Institut de Medicine Aerospatiale Armee, France; Poisson, R., Institut de Medicine Aerospatiale Armee, France; Selection and Training Advances in Aviation; Nov. 1996; 10p; In French; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Simulation used in aviation has been with us in some shape or form since the early 40's. These early devices were primarily used to teach basic flying skills and because of their simplicity had known limitations. Today's simulators are very expensive, complex and demanding devices which attempt to approximate the real world. They provide, not unlike the real aircraft, a multi-use capability where they are used for everything from teaching basic flying skills to mission rehearsals and accident investigation. These costly complicated systems sometimes provide questionable results because the designers, buyers, users and human factors specialists (which are all to often not involved) have not established a well defined set of requirements with respect to the simulators primary use. Nor do they fully understand the transfer of training from the simulator to the real world. to help understand or improve the transfer of training, human factors personnel should be involved in almost every facet of the simulators from conception to inception.
Author
Human Factors Engineering; Training Simulators; Transfer of Training

19970012413 Thomson Training and Simulation Ltd., Clergy Pontoise, France
THOMSON TRAINING AND SIMULATION
Lacroix, Michel, Thomson Training and Simulation Ltd., France; Fontaine, Jean-Jacques, Thomson Training and Simulation Ltd., France; Selection and Training Advances in Aviation; Nov. 1996; 6p; In French; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The performance features which a helmet visual display unit must have in order to satisfy requirements of low-altitude flight simulators and multi-purpose simulators are analyzed here. The design of the SIMEYE 90 large field helmet visual display unit which allows one to satisfy these requirements is analyzed and the technical compromises are explained. The results from using the helmet visual display unit on a helicopter simulator are then presented. They allow one to achieve better performance than when using screen projection, with the exception of weight which is found to be disturbing by pilots who are not accustomed to wearing night vision binoculars.
Author
Flight Simulators; Display Devices; Helicopters; Helmets; Night Vision

19970026383 Armstrong Lab., Noise Effects Branch, Wright-Patterson AFB, OH United States
THE EFFECTS OF SPATIAL AUDITORY PREVIEW ON VISUAL PERFORMANCE
Elias, Bartholomew, Armstrong Lab., USA; Jun. 1997; 8p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Since the auditory system is not spatially restricted like the visual system, spatial auditory cues can provide information regarding an object's position, velocity, and trajectory beyond the field of view. Recent studies (e.g., Perrott, Cisneros, McKinley, & D'Angelo, 1995) have demonstrated performance benefits in static visual search tasks over large spatial extents when visual targets have been augmented with spatial auditory position cues. The benefits of spatial auditory display augmentation have also been demonstrated in applied settings such as airborne traffic collision avoidance systems (Begault, 1993). Research has also shown that spatial auditory displays are potentially useful for enhancing cockpit situational awareness and reducing visual workload in tactical aircraft operations (McKinley. et al., 1994). The research program described here adds to these initial findings regarding the utility of spatial auditory displays by demonstrating that visual displays can be augmented with dynamic spatial auditory preview cues that provide information regarding the relative position. velocity, and trajectory of objects beyond the field of view. In one experiment, the effects of a spatial auditory preview display were examined in a visual target aiming task. A moving sound source provided cues regarding the position and velocity of moving targets prior to their appearance on the visual display. by providing these spatial auditory preview cues, greater accuracy was achieved in the visual target aiming task. In a second experiment, dynamic spatial auditory cues presented through headphones conveyed preview information regarding target position, velocity, and trajectory beyond the field of view in a dynamic visual search task. The provision of spatial auditory preview cues significantly reduced response times to acquire and identify moving visual targets that traversed a cluttered display and significantly reduced error rates in target classification. These

findings demonstrate that spatial auditory preview can augment visual displays and enhance performance in complex, dynamic task domains such as aviation.
Author
Display Devices; Audio Equipment; Cockpits; Collision Avoidance; Flight Operations; Visual Tasks; Auditory Perception; Auditory Signals

19970026390 Aeronautical Research Labs., Air Operations Div., Melbourne, Australia
THE ABILITIES OF LISTENERS TO LOCALISE DEFENCE RESEARCH AGENCY AUDITORY WARNINGS
Martin, Russell L., Aeronautical Research Labs., Australia; Parker, Simon P. A., Aeronautical Research Labs., Australia; McAnally, Ken I., Aeronautical Research Labs., Australia; Oldfield, Simon R., Aeronautical Research Labs., Australia; Jun. 1997; 8p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Defense Research Agency (DRA) in collaboration with the Applied Psychology Unit at Cambridge University and the Institute of Sound and Vibration Research at Southampton University have designed a set of 12 auditory warnings for use in military aircraft. These warnings have recently been modified to extend their high-frequency content in an attempt to increase the accuracy with which they can be localized and therefore enhance their suitability for use in conjunction with a 3D audio display. We have evaluated the abilities of listeners to localize a sample of the original DRA auditory warnings and their high-frequency versions. Eight subjects localized broadband noise and five original warnings when presented from a loudspeaker at each of 40 locations ranging from -40 to +40 deg azimuth and -50 to +50 deg elevation in their frontal hemifields. Subjects were divided into two groups of four subjects each on an age basis: 22-28 year olds and 33-48 year olds. Consistent with the results of previous studies, an average localization error of about 5 deg was observed for a train of three 150 ms bursts of broadband noise for both age groups. Average localization errors for the five original auditory warnings, however, were much larger and varied from about 10 to 25 deg for the younger subjects and 15 to 30 deg for the older. Four subjects, aged from 23-39 years, then localized three modified versions of two of these original warnings. of the three modification methods employed, only one (fine-structure doubling) produced stimuli that were localized more accurately than their original versions. The improvement in localization accuracy for stimuli modified by this method resulted primarily from an improvement in the accuracy with which the elevation of the stimulus could be determined.
Author
Military Aircraft; Auditory Perception; Warning Systems; Sound Localization; Audio Equipment; Display Devices; Voice Communication

19970034935 Oklahoma Univ., School of Industrial Engineering, Norman, OK United States
USE OF OBJECT ORIENTED PROGRAMMING TO SIMULATE HUMAN BEHAVIOR IN EMERGENCY EVACUATION OF AN AIRCRAFT'S PASSENGER CABIN
Court, Mary C., Oklahoma Univ., USA; Marcus, Jeffrey H., Civil Aeromedical Inst., USA; Sep. 1997; 8p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The paper presents an object-oriented framework to model human behavior under both certification and accident evacuations. The framework opens up a new area of analysis by proposing a paradigm for predicting human behavior. Object oriented programming lends itself to the modeling of complex systems by supporting a one-to-one correspondence with the physical world, and thus, eases the burden of model validation. Easing model validation is of particular importance when the real-system's environment is hazardous, and performing tests on the real-system is either impossible or not repeatable.
Author
Evacuating (Transportation); Emergencies; Human Behavior; Passengers; Aircraft Safety; Passenger Aircraft; Object-Oriented Programming; Mathematical Models; Safety Factors; Complex Systems

19970034936 Cranfield Univ., Dept. of Applied Psychology, Bedford, United Kingdom
PASSENGER PROTECTION AND BEHAVIOUR
Muir, H. C., Cranfield Univ., UK; Cobbett, A., Cranfield Univ., UK; Sep. 1997; 6p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The world-wide accident statistics indicate that the number of accidents has decreased over the last two decades. Unfortunately, the dramatic reduction in the overall accident rate was accompanied by a less dramatic reduction in the fatality rate of those onboard an aircraft which is involved in an accident. Nevertheless, recent analyses conducted by the FAA have indicated that fire has become less of a risk; in survivable accidents. In the early 1980s, FAA attributed 40 percent of fatalities in survivable accidents to fire effects. A review of US airline accidents that occurred between 1985 and 1991 showed that approximately 10 percent of fatalities were related to fire. Whilst no two accidents can be the same, it is possible to learn from the similarities and difference between the cause of the accidents, their location, and the environmental condition present, the types of passengers onboard and their responses to the emergency. There are a great many questions which as yet we are not able to answer about the behaviour of people in emergencies, including the important question of why in some accidents the passengers evacuate in an orderly manner, and in other accidents the behaviour is disorderly. This paper discusses an evacuation technique that has a potential to provide both the behavioural and statistical data required for assessment of design options or safety procedures for use in emergency evacuations.
Derived from text
Passengers; Human Behavior; Evacuating (Transportation); Aircraft Safety; Flight Crews

19970034937 Greenwich Univ., Fire Safety Engineering Group, London, United Kingdom
THE ROLE OF EVACUATION MODELLING IN THE DEVELOPMENT OF SAFER AIR TRAVEL
Galea, E. R., Greenwich Univ., UK; Owen, M.; Greenwich Univ., UK; Lawrence, P., Greenwich Univ., UK; Sep. 1997; 14p; In English; See also 19970034906; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Computer based mathematical models describing the aircraft evacuation process have a vital role to play in the design and development of safer aircraft, in the implementation of safer and more rigorous certification criteria and in post mortuum accident investigation. As the risk of personal injury and costs involved in performing large-scale evacuation experiments for the next generation Ultra High Capacity Aircraft (UHCA) are expected to be high, the development and use of these evacuation modeling tools may become essential if these aircraft are to prove a viable reality. In this paper the capabilities and limitations of the air-EXODUS evacuation model are described. Its successful application to the prediction of a recent certification trial, prior to the actual trial taking place, is described. Also described is a newly defined parameter known as OPS which can be used as a measure of evacuation trial optimality. Finally, the data requirements of aircraft evacuation models is discussed along with several projects currently underway at the University of (Greenwich designed to obtain this data. Included in this discussion is a description of the AASK - Aircraft Accident Statistics and Knowledge - data base which contains detailed information from aircraft accident survivors.
Author
Mathematical Models; Evacuating (Transportation); Aircraft Design; Aircraft Safety; Aircraft Accidents; Air Transportation

19980033539 Mayo Clinic, Div. of Preventive Medicine and Cardiovascular Disease, Rochester, MN United States
PSYCHOPHYSIOLOGICAL READINESS AND SUSTAINABILITY
Hickman, J. R., Jr., Mayo Clinic, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 14p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

As the NATO alliance enters into a new era, with new roles and new missions, a new R&D structure will emerge. AGARD has been a splendid organization, existing at the heart of the alliance. It seems that NATO must now move beyond an information sharing and advisory role to a sponsor of multinational scientific projects. It is time to take advantage of the combined sample size in order to reach significant

conclusions sooner and with greater confidence. It is time to organize our centers of excellence into a collaborative mode in order to assure that the human subsystem is both affordable and effective. In several key areas of aerospace medical research, there is no alternative to the NATO sponsored multinational project.
Derived from text
North Atlantic Treaty Organization (NATO); Research and Development; Aerospace Medicine; Psychophysiology

19990014354 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
DRAWING ON TODAY'S WISE INVESTMENTS: LONGITUDINAL AND BASELINE HUMAN-RESOURCE RESEARCH
King, R. E., Advisory Group for Aerospace Research and Development, France; McGlohn, S. E., Advisory Group for Aerospace Research and Development, France; Retzlaff, P. D., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 3-6; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Many of the pilots who will be flying in the year 2020 are just now being born or are currently very young children. We will know more about these pilots than we presently know about our current pilots. The air forces of the future will surely include many more women as they will likely compete on an equal footing and may be represented in all cockpits. Efforts currently underway, including Neuropsychiatrically Enhanced Flight Screening, Assessment of Psychological Factors in Aviators and Psychological Factors of Aviators' Success may bear fruit and answer the question of whether female pilots self-select into aviation or if they are shaped as a result of the process of pilot training. The year 2020 may see the Armstrong Laboratory Aviator Personality Survey as a well established test for use with aviators, with international norms. As we invest increasingly large amounts of money into each individual airframe and mission, we must learn more about the human operator, whether that individual is a pilot or a controller of a pilotless aircraft or spacecraft (Uninhabited Aerial Vehicle).
Author
Human Resources; Aircraft Pilots; Personnel Development; Human Performance

19990025683 Air Force Research Lab., Sustained Operations Branch, Brooks AFB, TX United States
EVALUATING CREW PERFORMANCE AFTER ANTI-EMETICS: A SCREEN FOR ASSESSING MILITARILY RELEVANT MEDICATIONS
French, Jonathan, Air Force Research Lab., USA; Benline, Terry A., Air Force Research Lab., USA; Poole, Eric, Air Force Research Lab., USA; September 1998; 10p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Prophylactic, pharmaceutical countermeasures hold the potential to protect aircrews from a wide variety of threats during contingency operations, ranging from fatigue to radiation exposure. In order to assess the impact of these potential countermeasures on cognitive abilities, a 2-phase drug screen was developed. A battery of cognitive, affective and physiological measures was utilized in Phase I of testing to rapidly evaluate the performance liability of militarily relevant compounds. The carefully controlled Phase I lab study incorporated diurnal and nocturnal performance trials to assess potential drug interactions with circadian and sleep deprivation effects. During Phase II, flight performance was tested in a high fidelity aircraft simulator using embedded operational tasks, expert evaluation and subjective metrics. The Phase I screen evaluated two novel anti-emetic compounds, granisetron (2 mg) and ondansetron (8 mg), compared to placebo and a positive control, prochlorperizine (10 mg), in a double blind, crossover study of 24 subjects. Performance was assessed hourly from 1800 until 0200. All Phase I metrics were degraded during nocturnal performance trials for all drug conditions, presumably due to circadian and sleep deprivation effects. The positive control was identified by the divided attention task in terms of accuracy ($p < 0.05$) and reaction time ($p < 0.05$) and by the mean lambda for the tracking task ($p < 0.05$), but only during a time when blood levels of prochlorperizine were elevated. None of the affective state questionnaires were able to identify the positive control, suggesting that the dose was low enough that the participants were unable to discern it. None of the target anti-emetic compounds differed from placebo suggesting that they were not likely to affect sensitive performance. Phase II also revealed no differences between target anti-emetic compounds and placebo in any of the segments of an F-16 defensive counter-air mission flown by 9 pilots. Based on these tests, the target compounds were considered safe to use prophylactically, with respect to cognitive ability, for crews in danger of radiation exposure. The utility of the drug screen as a rapid and thorough means to assess the cognitive impact of militarily relevant compounds was established.
Author
Performance Tests; Countermeasures; Antiemetics and Antinauseants; Flight Crews; Drugs; Human Performance; Radiation Dosage; Sleep Deprivation

19990025684 Clarke Inst. of Psychiatry, Toronto, Ontario Canada
MELATONIN AND ITS ROLE IN CIRCADIAN RHYTHM DISRUPTION
Brown, Gregory M., Clarke Inst. of Psychiatry, Canada; Vos, Evert C., Clarke Inst. of Psychiatry, Canada; September 1998; 10p; In English; See also 19990025670; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Melatonin, the hormone of the pineal gland, is secreted during the hours of darkness with virtually no secretion during light and has therefore been called the hormone of darkness. Its secretion is controlled by an endogenous rhythm generating system that is entrained by light. Melatonin has a role in cuing circadian rhythms, notably the sleep-wake rhythm, promoting sleep, and contributing significantly to the circadian rhythm in body temperature. Specific receptors for melatonin have been cloned recently which mediate these and other effects. (Melatonin can be given orally, intravenously, by nasal spray or transbucally and has a wide safety margin.) Administration of melatonin orally (in a dose of 0.5 to 5 mg) or light treatment (300 to 5000 lux) has established therapeutic actions in circadian rhythm sleep disorders, including disorders associated with jet lag, shift work, delayed phase sleep disorder, periodic sleep disorder in blindness and sleep and behavioural disorders in children with multiple brain damage. Treatment of circadian rhythm disorders with light or melatonin requires an understanding of the manner in which these agents produce effects on body rhythms. Effects of light and melatonin treatment follow a phase response curve. Evening light treatment causes a phase delay in the sleep-wake cycle while morning light causes a phase advance. As is befitting the hormone of darkness, melatonin treatment produces effects which are nearly the mirror image of light.
Author
Circadian Rhythms; Light (Visible Radiation); Sleep; Hormones; Regulatory Mechanisms (Biology)

19990032480 Advisory Group for Aerospace Research and Development, Human Performance Modelling Working Group, Neuilly-Sur-Seine, France
[OVERVIEW OF THE GUIDE TO HUMAN PERFORMANCE MODELING]
A Designer's Guide to Human Performance Modelling; December 1998, 1-33; In English; See also 19990032479; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This report is comprised of Chapters 1 through 7 of the Designer's Guide to Human Performance Modeling, presented by Working Group-22 as a joint effort between the Flight Vehicle Panel and the Aerospace medical Panel of AGARD. Chapter 1 of the Designer's Guide presents a brief description and the current status of Human Performance Modeling followed by an outline of the organization of the report as a whole. The remaining chapters, 2 through 7 discuss the following topics: 1) Applications of HPM's (Human Performance Models); 2) Taxonomy of Models; 3) Model Limitations; 4) Implementation Issues; 5) Description of the Expert System; and 7) Recommendations for future work.
CASI
Human Performance; Complex Systems; Systems Engineering; Models

19990032481 Defence Evaluation Research Agency, Centre for Human Sciences, Farnborough, United Kingdom
WORKED EXAMPLE OF THE USE OF IPME IN THE EVALUATION OF SYSTEM EFFECTIVENESS
Belyhavin, Andy, Defence Evaluation Research Agency, UK; A Designer's Guide to Human Performance Modelling; December 1998, A1-1 - A1-16; In English; See also 19990032479; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The Integrated Performance Modelling Environment (IPME) programme was established in 1995 in the UK Ministry of Defence Corporate Research Programme (CRP) under TG5 with the objective of developing a methodology for quantifying the human performance to system effectiveness. The approach adopted to meeting this requirement, was to develop a software framework based on earlier US work, which would permit the description of the human interaction with the system and the environment based on a task analysis approach. The software framework provides the means to simulate the interaction between man and system based on a task network logic flow.
Derived from text
System Effectiveness; Human Performance; Models; Man Machine Systems; Systems Engineering; Human Factors Engineering; Computer Systems Design

19990032482 Roke Manor Research Ltd., Romsey, United Kingdom
WORKED EXAMPLE OF THE USE OF PUMA IN A FUNCTION ALLOCATION TASK
Day, P., Roke Manor Research Ltd., UK; A Designer's Guide to Human Performance Modelling; December 1998, A2-1 - A2-5; In English; See also 19990032479; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

The PUMA method and toolset was used in an allocation of function study, involving the reengineering of a major civil Air Traffic Control system. As is the case in advanced, process-control like systems, one of the major issues facing designers is the extent to which functions formerly undertaken by humans in the system may usefully be automated. In the case of ATC systems, safety remains the paramount consideration, but there is also a growing requirement to increase system throughput as the levels of civil air traffic continue to grow. For this reason, civil aviation authorities around the world are increasing their level of investment in ATC systems, and in many cases replacing obsolete systems with new technology. ATC remains however a human-centered control activity, a situation that is unlikely to change in the foreseeable future, and hence one of the major issues that faces designers is the extent to which system functions may usefully be delegated to computer control while still keeping the human firmly in the loop. The study described was undertaken in this context, and is an illustration of the use of the PUMA method and toolset for the purposes of task analysis and workload estimation, thus enabling decisions on functional allocation to be taken.
Derived from text
Systems Engineering; Air Traffic Control; Control Systems Design; Tasks; Workloads (Psychophysiology)

19990032486 British Aerospace Public Ltd. Co., Sowerby Research Centre, Filton, United Kingdom
WORKED EXAMPLE OF THE ORACLE TARGET ACQUISITION MODEL
Emmerson, P., British Aerospace Public Ltd. Co., UK; A Designer's Guide to Human Performance Modelling; December 1998, A6-1 - A6-14; In English; See also 19990032479; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The following description makes up the problem space for the Target Acquisition Model. A designer is asked to provide a human operator with optimised values for the gain on an electro-optical sensor system in a land fighting vehicle. The gain (or 'temperature window') is known to affect target acquisition, and the designer decides to issues guidelines for the optimum gain for specific situations, based on predictions from a human visual target acquisition model. The chosen model, ORACLE, predicts target acquisition performance under a wide range of conditions, and can include performance with a variety of sensors. For this example, the thermal imaging model is used, in which a single parameter (gain) is iterated over a realistic range for the TI, for a single scenario (a given target and environmental conditions). A complete solution to the designers requirement would involve iterations over other variables (for example different atmospheric visibilities), but all such iterations would follow the procedure outlined). It is to be noted that this example has been chosen to show the potentially wide range of input parameters that can be used. The remainder of the report is made up of the process description, input/outputs from the case study, solution description and facility/resource requirements.
Derived from text
Target Acquisition; Models; Electro-Optics; Performance Prediction

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MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

19950017181 Advisory Group for Aerospace Research and Development, Guidance and Control Panel, Neuilly-Sur-Seine, France
KNOWLEDGE-BASED GUIDANCE AND CONTROL FUNCTIONS ***APPLICATION DES SYSTEMES EXPERTS POUR LE GUIDAGE ET LE PILOTAGE***
Jan 1, 1995; 183p; In English
Report No.(s): AGARD-AR-325; AD-A292118; ISBN 92-836-1009-1; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

This report summarizes the deliberations of Working Group 11 of the Guidance and Control Panel of AGARD. The objectives of the Working Group are: (1) analyze the structure of knowledge-based guidance and control functions related to aircraft, missions, and the battlefield and identify their potential for automation; (2) analyze the structure of knowledge-based guidance and control functions related to the life cycle of guidance and control systems, and identify their potential for automation; (3) review the state-of-the-art of those software and hardware oriented technologies required for the transfer of the knowledge-based G&C functions to automatic systems; (4) review existing programs; and (5) make recommendations for future work.
Author
Aircraft Guidance; Artificial Intelligence; Automatic Control; Automation; Computer Programs; Control Systems Design; Human-Computer Interface; Knowledge Based Systems

19950023203 Department of the Air Force, Armstrong Lab., Brooks AFB, TX, United States
AEROMEDICAL IMPACT OF THE TRANSPORTABLE PRESSURE VENTILATOR IN WARTIME AEROMEDICAL EVACUATION
Richardson, L., Department of the Air Force, USA; Munson, R., Department of the Air Force, USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 5 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

Mechanical ventilation permits the early air transport of patients in respiratory failure. Ventilator-dependent patients have been successfully air transported since the 1970's in the USA Air Force (U.S.A.F.) peacetime aeromedical evacuation system. The selection of suitable ventilation equipment, patient management and related safety issues, such as ventilator performance characteristics during rapid decompression, have been previously reviewed. During peacetime aeromedical operations, space is not usually an issue and volume ventilators are generally used. During wartime operations the bulky volume ventilator and the 100 volt AC (VAC) at 60 Hz electrical power converter are not readily available and take up too much space to be used on the C-130 and C-141 aircraft opportunely diverted from cargo missions to perform aeromedical evacuation. Each litter station in these cargo aircraft can hold up to ten litter patients. When a volume ventilator-dependent patient requires air transport, the litter station is typically reduced to only one or two litters. Recent conflicts such as Operations Just Cause and Desert Storm have refocused the need to provide acute care while enroute to definitive care. The projected large numbers of litter casualties and the potential increased demand for ventilator support for biological chemical or burn injuries during Desert Storm resulted in the distribution of the TXP ventilator to U.S.A.F. Aeromedical Staging Facilities. Use of the TXP ventilator has the potential of reclaiming the eight or nine litter positions lost during the air transport of a volume ventilator-dependent patient due to its ability to be attached to the patient's litter.
Derived from text
Aerospace Medicine; Air Transportation; Evacuating (Transportation); Medical Equipment; Medical Services; Ventilation; Ventilators

19950023205 Department of the Air Force, Scott AFB, IL, United States
CARE IN THE AIR: A SYSTEM ANALYSIS OF CLINICAL OUTCOMES IN AEROMEDICAL EVACUATION
Saenger, Arleen M., Department of the Air Force, USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 7 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

In 1993 a clinical outcomes study of the Continental USA (CONUS) Aeromedical Evacuation (AE) system was undertaken. Between 15 Feb. and 31 Oct. 1993, AE patients were screened for a

series of adverse clinical outcome indicators and process discrepancy indicators. Rates were determined for each of the indicators. Defense Medical Regulating Information System (DMRIS) records were reviewed to obtain patients' demographic data. Correlations between diagnoses and adverse clinical outcomes were evaluated. During AE missions the adverse clinical outcome rate was 0.9 per 1000 patients. Unanticipated need for O2 and development of chest pain in flight accounted for 73 percent of the in-flight adverse outcomes and occurred primarily in cardiac patients. The process discrepancy rate was 10 per 1000 patients - 10 times the adverse outcome rate. For patients remaining over night in Aeromedical Staging Facilities the adverse outcome rate was 2.9 per 1000 patients. ENT barotrauma accounted for 66 percent of these patients. The adverse clinical outcome rate for peacetime AE patients is very low. Patients with limited cardiopulmonary reserve are at higher risk during AE. During wartime and military operations other than war, AE patients are more likely to have limited cardiopulmonary reserve and be at higher risk due to injuries, malnutrition, or limited medical care prior to flight. Special attention to oxygen requirements, altitude restrictions, complete documentation of care required en route, and proper selection of medical attendants are crucial for good outcomes in AE.
Author
Aerospace Medicine; Air Transportation; Diagnosis; Evacuating (Transportation); Medical Services; Patients

19950026068 Naval Air Warfare Center, Targeting Systems Integration Section., China Lake, CA, United States
MULTISPECTRAL IMAGE CORRELATION FOR AIR-TO-GROUND TARGETING
Ditzler, W. R., Naval Air Warfare Center, USA; Boyd, M. J., Naval Air Warfare Center, USA; Corcoran, T. J., Naval Air Warfare Center, USA; Franklin, M. S., Naval Air Warfare Center, USA; Mcknight, J. E., Naval Air Warfare Center, USA; Ottenhoff, H. C., Naval Air Warfare Center, USA; Tyhurst, R. W., Naval Air Warfare Center, USA; Wirtz, M. M., Naval Air Warfare Center, USA; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 12 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

A primary cause of failure in tactical air-to-ground missions is the the aircrew fails to find the assigned target. This is the case even for missions against preassigned, large, stationary targets, such as bridges, supply depots, and air-defense sites, for which reconnaissance and satellite images of the target and its surroundings are available for the mission planning process. An important reason for this poor performance is the limited time available for target acquisition, especially when target defences necessitate low-level ingress. During the time a target is visible to aircraft sensors, the aircraft is also visible to the target's defense systems. The time required for air-to-ground targeting with present systems (for example, to lock a targeting FLIR onto an aimpoint is comparable to the response time of air defense systems. Clearly, minimizing the time needed to find and recognize targets is crucial for making attack missions more survivable. Survivability is enhanced if the attack mission can be carried out without the need to 'pop up' to use a targeting sensor. In a typical low-level attack mission, 8-10 s is available for the targeting process, from appearance of the target to weapon release. However, a pilot cannot remove his attention from flying the aircraft for this length of time, especially at night using night-vision systems. Pilots who have tested night-vision systems for low-level flight estimate that 1.5-2.0 s is the maximum allowable time to concentrate on a head-down display under these conditions. A near-term solution to the targeting problem must let the human operator make the final decision. The system described in this paper automates the search for the target (or an offset aimpoint) by sending video from one or more of the aircraft sensors to an image correlator. The correlator finds the best match to an image of the target area, supplied from mission planning data, and displays the resulting target position overlaid on the sensor image. The aircrew is required to look at a head-down display only long enough to confirm of deny the correlator's result. The correlator can then automate the process of locking an image missile seeker onto target.
Derived from text
Display Devices; FLIR Detectors; Homing Devices; Image Correlators; Infrared Tracking; Laser Targets; Night Vision; Satellite Imagery

19950026083 Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan, Italy
SIRPH: STEERABLE INFRARED PICTURE ON HELMET MOUNTED DISPLAY
Balzarotti, Giorgio, Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; Fiori, Lorenzo, Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; Midollini, Beatrice, Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Helmet Mounted Displays (HMD's) are being paid remarkable attention as an essential aid to pilots of both fixed and rotary wing aircraft: The technological improvements such equipment are experiencing place them in an outstanding position among avionics. A very important role in the success of HMD's is played by the management of man-machine-interface aspects: The way to make the information available, in a useful format, to the pilot must be considered with particular care. A smart example is the presentation of images from steerable sensors: The head tracking systems have actually achieved a high degree of accuracy, thus allowing a precise control of the Line of Sight (LOS) of electrooptical vision systems. Therefore, pictures generated by a steerable infrared sensor slaved to the pilot's head movements can be displayed onto the helmet visor, in order to provide the pilot with a substantial aid in day and night, adverse weather conditions, high altitudes down to low level and nap of the earth flight operations. The paper describes the results of a technical analysis performed on a system based on a steerable IR sensor integrated with an advanced HMD for navigation aid purposes. The parameters which lead to an imperfect static or dynamic overlay of the generated IR picture with the external world, as seen by the pilot through the helmet visors, and the effects of such misalignment are analyzed in detail, together with integration aspects and human engineering factors. The analysis has also taken into account the finite angular excursion of the IR sensor LOS, originated by gimbals limits, and the consequent necessary transition to and from the LLTV's integrated within the helmet, suitable to cover all possible head motions, has been investigated. An approach to the problem of the fusion of information generated by the IR sensor and the LLTV's is also reported. Finally, the paper highlights the limits and the constraints of navigation using a steerable IR sensor, with respect to safety aspects.
Author
Air Navigation; Daytime; Electro-Optics; FLIR Detectors; Helmet Mounted Displays; Holography; Human Factors Engineering; Infrared Imagery; Infrared Radar; Navigation Aids; Night Vision

19950026718 Moscow Inst. of Aviation Technology, Simulators and Pilot-vehicle Lab.; **USSR**
DEVELOPMENT AND APPLICATION OF THE METHODS FOR PILOT-AIRCRAFT SYSTEM RESEARCH TO THE MANUAL CONTROL TASKS OF MODERN VEHICLES
Efremov, A. V., Moscow Inst. of Aviation Technology, USSR; Ogloblin, A. V., Moscow Inst. of Aviation Technology, USSR; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 12 p; In English; See also 19950026705; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

There are discussed the influence of some typical for the modern vehicles features (high frequency phase delay and nonliniarities in flight control system (FCS)) and parameters of input spectral density corresponding to the real piloting tasks on pilot response characteristics. There are developed some new standard characteristics the optimal aircraft dynamics and discomfort frequency response, and demonstrated their efficiency for the several applied tasks in design of FCS and development of requirements to the handling qualities. There are discussed the ways for suppression of pilot limitation parameters and FCS nonlinear and phase delay effects.
Derived from text
Control Systems Design; Flight Control; Frequency Response; High Frequencies; Manual Control; Pilot Performance; Tasks

19950027629 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
CURRENT CONCEPTS ON G-PROTECTION RESEARCH AND DEVELOPMENT *CONCEPTS ACTUELS EN RECHERCHE ET DEVELOPPEMENT POUR LA PROTECTION ANTI-G*
May 1, 1995; 128p; In English, 15-16 May 1995, Ohio, Koenigsbrueck,

Farnborough, United States*Germany*UK, Germany, UK; See also 19950027630 through 19950027639
Report No.(s): AGARD-LS-202; ISBN 92-836-0016-9; Copyright Waived; Avail: CASI; A07, Hardcopy; A02, Microfiche

A new class of fighter aircraft is emerging that will be operational or in advanced Test and Evaluation (T&E) by 1995. These aircraft (e.g. MiG 31, YF-22, Eurofighter, Rafale) are capable of developing G far in excess of 9G (i.e. 12G will be a realistic capability). The operational envelope of these agile aircraft will depend upon the G protection provided to the aircrew. In response to this challenge, established and new laboratories using human-use centrifuges are developing new aircrew protection methods. These laboratories include Armstrong Laboratory (US), SAM (UK), DCIEM (CA), LAMAS (FR), SAM (RU), KONIGSBRUCK Laboratory (GE) and FOA Laboratory (SW). In 1995, much of this research will have produced prototype flight-worthy equipment/methods with advanced understanding of their physiological bases. This lecture series reviews (1) pathophysiology of high sustained G (9G and above) and (2) recent equipment development and reports on T&E.
Acceleration Protection; Aerospace Medicine; Fighter Aircraft; Flight Clothing; Gravitational Physiology; High Gravity Environments

19950027630 Armstrong Lab., Crew Technology Div., Brooks AFB, TX, United States
G-PROTECTION BASIS/ACCELERATION PHYSIOLOGY
Burns, J. W., Armstrong Lab., USA; AGARD, Current Concepts on G-Protection Research and Development; May 1, 1995, 10 p; In English; See also 19950027629; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Our major objective is to protect the aircrew against the detrimental effects of +Gz by developing and assessing equipment and techniques to enhance high sustained acceleration (+Gz) tolerance, and minimize the hazards of G-LOC. The payoff is reduced pilot fatigue and improved combat effectiveness. To accomplish these objectives it is imperative that we learn as much as possible regarding acceleration physiology and the influence that protective equipment and techniques have on acceleration physiology.
Derived from text
Acceleration Protection; Acceleration Tolerance; Aerospace Medicine; Flight Clothing; Gravitational Physiology; High Acceleration; Supine Position

19950027634 Royal Air Force Inst. of Aviation Medicine, Farnborough, United Kingdom
POSITIVE PRESSURE BREATHING FOR G PROTECTION (PBG)
Prior, A. R. J., Royal Air Force Inst. of Aviation Medicine, UK; AGARD, Current Concepts on G-Protection Research and Development; May 1, 1995, 16 p; In English; See also 19950027629; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

Modern, high performance, combat aircraft are capable of high sustained +Gz acceleration, at high G onset rates, for which enhanced G protection of the pilot is required if the performance of the aircraft is not to be limited by the capabilities of the pilot. Given that the pilot is essentially seated upright in the cockpit, the most suitable system of enhanced G protection is that of positive pressure breathing (PBG) with the possible addition of new anti-G trousers having considerably greater bladder coverage than previous garments. PBG used with in-service anti-G trousers reduces pilot fatigue and doubles G endurance. An anti-G straining maneuver (AGSM) is still required as the relaxed G tolerance of the pilot is increased by only 1G. PBG used with full or extended coverage anti-G trousers enables the pilot to tolerate 8G without needing to employ the AGSM and provides a high degree of protection against G-induced loss of conscious. However, the increased bladder coverage of the trousers, and that of the chest counterpressure garment which is probably required for PBG, imposes a higher heat load on the pilot and has a tendency to reduce mobility. In addition, the oxygen mask must be capable of effecting an adequate seal of the PBG pressure against the face without user intervention; furthermore the system must be compatible with helmets containing display and sighting systems and be capable of use with NBC protective systems. Development PBG systems have yet to be fully optimized and their routine use by aircrew requires further assessment particularly with regard to the longer term consequences.
Author
Acceleration Protection; Acceleration Tolerance; Aerospace Medicine; Flight Clothing; High Acceleration; Oxygen Masks; Pressure Breathing

19950027639 Department of the Air Force, Crew Technology Div., Brooks AFB, TX, United States
G-PROTECTION CAPABILITIES AND CURRENT G-PROTECTION ISSUES
Burns, J. W., Department of the Air Force, USA; AGARD, Current Concepts on G-Protection Research and Development; May 1, 1995, 8 p; In English; See also 19950027629; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Acceleration tolerance and protection of female pilots, relationship between time away from +Gz exposure (G-layoff) and a reduced G tolerance, and +Gz-induced loss of consciousness (G-LOC) are discussed. G tolerance and endurance capabilities are reflections of the pilot's strength. While within gender there is a poor correlation (average 0.2) between body size and strength, males as a group are significantly stronger than females. Current +Gz protective equipment has been designed using male anthropometry. Two modifications were made to the anti-G suit to provide a better fit for female pilots: (1) a V-shaped dart in the lumbar restraint material to bring the suit in at the waist and (2) a lowered upper edge of the abdominal bladder below the rib cage in the seated position. Anecdotal information suggests a positive relationship between G-layoff and reduced G tolerance. The reduced endurance observed in this study may reflect the reduced +Gz tolerance reported to follow G-layoff, but they are not related to changes in aerobic or anaerobic metabolism, or relaxed responses to +Gz. The anti-G straining maneuver (AGSM) is a major factor in the maintenance of vision and consciousness for most pilots during high levels of +Gz. G-LOC is unique to the flight maneuvering environment in that it occurs in healthy aircrew. It is insidiously dangerous because it can happen with little or no warning. Cessation of cerebral blood flow, kinetics and secondary characteristics, and convulsions during G-LOC are discussed.
CASI
Acceleration Protection; Acceleration Tolerance; Aerospace Medicine; Aircraft Pilots; Blackout (Physiology); Females; High Acceleration; Physiological Tests

19960020525 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
ADVANCED OXYGEN SYSTEMS FOR AIRCRAFT *SYSTEMES D'OXYGENE AVANCES*
Ernsting, John, Editor, Royal Air Force, UK; Miller, Richard L., Editor, Armstrong Lab., USA; Apr. 1996; 112p; In English
Report No.(s): AGARD-AG-286; ISBN 92-836-1033-4; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

Many of the oxygen systems fitted to present NATO aircraft are unsatisfactory as they employ liquid oxygen which requires a complex and expensive supply chain, they impose undesirable physiological loads on the aircrew, particularly high resistance to breathing, and they do not provide pressure breathing with +Gz or effective protection to the respiratory tract and eyes against NBC agents. Advanced Oxygen Systems (AOS), which provide on board generation of breathing gas, impose a low physiological load on the aircrew and provide pressure breathing with G and at high altitude and protection against NBC agents, are required in the new generation of very agile high performance combat aircraft now under development by the NATO nations. This monograph provides a comprehensive review of the present state of development of AOS for combat aircraft and provides practical guidelines for the future development of these systems. The monograph comprises an introduction; conventional US and UK oxygen systems and their deficiencies; the history of development of on-board oxygen generating systems, OBOGS; operational requirements and design of AOS; physiological requirements for AOS; molecular sieves, pressure swing adsorption and oxygen concentrators; breathing gas regulators and masks for AOS; current molecular sieve oxygen generation systems; sensors, indicators and controls for AOS; practical aspects of design of AOS; and effects of contaminants, including chemical warfare agents, on molecular sieve oxygen generators; and

an index. This monograph will be of value to all those concerned with the design, procurement and operational use of Advanced Oxygen Systems to be fitted to future high performance combat aircraft.
Author
Life Support Systems; Breathing Apparatus; Fighter Aircraft; Pressure Breathing; Supersonic Aircraft; Oxygen Masks; High Altitude Breathing; Acceleration Protection

19960023122 Defence Research Agency, Farnborough, Human-Factors Group., Hampshire, United Kingdom
DESIGNING NOVEL HEAD-UP DISPLAYS TO PROMOTE SITUATIONAL AWARENESS
Hardiman, T. D., Defence Research Agency, Farnborough, UK; Dudfield, H. J., Defence Research Agency, Farnborough, UK; Selcon, S. J., Defence Research Agency, Farnborough, UK; Smith, F. J., Defence Research Agency, Farnborough, UK; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 15-1 - 15-7; In English; See also 19960023107; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper considers the design of attitude symbology for Head-Up Displays and describes two experimental studies conducted at DRA Farnborough. In these studies, novel and current HUD formats were compared in a range of tasks requiring attitude awareness. Both studies compared the novel formats in a fixed-based simulator using a 'recovery from unusual position' flight task and task-performance was measured. The trials differed in terms of the 'design driver' data taken. The first used workload ratings (NASA Task Lead Index) and the second situational awareness (SA) ratings (Situational Awareness Rating Technique). Significant reaction time differences were found between the conditions in both studies. However, although these significant differences were supported by the SA ratings they were not reflected in the workload ratings. It is suggested that under certain trial conditions SA is a superior design driver to measure than workload, since workload does not include cognitive aspects of pilot performance such as prior knowledge and understanding.
Author
Head-Up Displays; Pilot Performance; Workloads (Psychophysiology); Tasks

19960023123 NASA Ames Research Center, Moffett Field, CA United States
SCENE-LINKED SYMBOLOGY TO IMPROVE SITUATION AWARENESS
McCann, Robert S., NASA Ames Research Center, USA; Foyle, David C., NASA Ames Research Center, USA; Situation Awareness: Limitations and Enhancement in the Aviation Environment; Jan. 1996, 16-1 - 16-11; In English; See also 19960023107; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper reviews recent research conducted in the Flight Management and Human Factors Division of NASA Ames Research Center on superimposed symbology (as found on HUDs and HMDs). We first identify various performance problems which suggest that superimposed symbology impairs pilots' ability to maintain simultaneous awareness of instrument information and information in the forward visual scene. Results of experiments supporting an attentional account of the impairment are reported. A design solution involving the concept of 'scene-linked' symbology is developed, and experiments testing the design solution are reported. An application of the scene-linking concept, in the form of a candidate HUD to support ground taxi operations for civil transport, is described.
Author
Head-Up Displays; Human Factors Engineering

19960045365 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
ANTHROPOMORPHIC DUMMIES FOR CRASH AND ESCAPE SYSTEM TESTING *MANNEQUINS ANTHROPOMETRIQUES UTILISES LORS DES TESTS D'IMPACT ET D'EJECTION*
Jul. 1996; 120p; In English
Report No.(s): AGARD-AR-330; ISBN 92-836-1039-3; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

Anthropomorphic dummies for crash and escape system testing have been used by military and civilian agencies for many years to assess, develop and standardize safer occupant restraint systems for land and air vehicles. The automotive industry has spent considerable effort in designing crash test dummies that are biofidelic; i.e., dummies that duplicate the properties of a representative human subject on which injury risk is to be assessed. This advisory report addresses the status and direction of the technology of aircraft ejection and automotive crash test dummies from the point of view of the following: historical review of important dummies developed in NATO; human biomechanical response requirements of current adult dummies; anthropometry of current adult dummies; injury tolerance criteria for impact exposure of these dummies; dummy instrumentation and data acquisition systems; new developments in dummies; mathematical models as human surrogates; and dummy users in NATO. Recommendations include the need for the following: relating aircraft system effectiveness testing to dummy injury criteria; full line of dummy sizes to accommodate entire flying population; enhanced dummy instrumentation and data acquisition systems; affordability of dummy acquisition, use and maintenance; and validation and increased use of mathematical models as human surrogates.
Author
Dummies; Escape Systems; Crashes; Anthropometry; Safety Devices; Ejection Seats; Bionics; Test Equipment

19970012389 Armstrong Lab., Human Engineering Div., Wright-Patterson AFB, OH United States
ASSESSMENT OF ANTHROPOMETRIC ACCOMMODATION IN AIRCRAFT COCKPITS AND PILOT BODY SIZE SELECTION CRITERIA
Zehner, Gregory F., Armstrong Lab., USA; Selection and Training Advances in Aviation; Nov. 1996; 6p; In English; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Designing high-performance aircraft cockpits to accommodate the wide range of body sizes existing in the US population has always been a difficult problem for Crewstation Engineers. to alleviate this problem, the US Air Force restricts the range of body sizes allowed into flight training, and then develops aircraft design standards and specifications around that reduced population. Limiting the size of the aircraft crewstation (and, therefore, the aircraft) should also reduce the cost and improve the performance of the aircraft.
Derived from text
Anthropometry; Cockpits; Crew Workstations; Pilot Selection; Aircraft Design

19970012404 Institut de Medicine Aerospatiale Armee, Bretigny sur Orge, France
THE APPLICATION OF HUMAN FACTORS FOR EQUIPMENT OF THE FRENCH AIR FORCE *LA FORMATION AUX FACTEURS HUMAINS POUR LES EQUIPAGES DE L'ARMEE DE L'AIR FRANCAISE*
Doireau, P., Institut de Medicine Aerospatiale Armee, France; Grau, J. Y., Institut de Medicine Aerospatiale Armee, France; Amalberti, R., Institut de Medicine Aerospatiale Armee, France; Valot, C., Institut de Medicine Aerospatiale Armee, France; Bouvet, J. L., French Air Force, France; Selection and Training Advances in Aviation; Nov. 1996; 6p; In French; See also 19970012387; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

French air force has defined in 1994 with IMASSA an 'human factors' policy to improve flight safety. This policy contents three ways: physical training program, experience feedback increasing, and 'human factors' training program. This article summarizes the main aspects of the definition and application of the 'human factors' training program.
Author
Human Factors Engineering; Flight Safety

19970018643 Institute for Human Factors TNO, Soesterberg, Netherlands
AN EXPLORATORY STUDY OF THE HUMAN-MACHINE INTERFACE FOR CONTROLLING MARITIME UNMANNED AIR VEHICLES
vanBreda, L., Institute for Human Factors TNO, Netherlands; Nov. 1996; 8p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Under contract by the Royal Netherlands Navy an exploratory study was conducted on the design of the user interface for Maritime Unmanned Air Vehicles (MUAVs) control. The goal of this study was to gain more insight into the various parameters that may influence system performance, given the present level of technology. Two simu-

lator experiments were conducted. Results of a first experiment made clear that the image transmission rate of the downlink is a critical factor. It appeared that with a single MUAV, only combined sensor and airframe control leads to an acceptable tracking performance, in particular at short observation distances. For low sensor image update frequencies (less than 4 Hz), tracking becomes critical. Results of a second experiment revealed that the tracking performance in a MUAV supervisory control task is identical to the first experiment, even in high auditive/cognitive workload conditions. It is suggested to focus further research on ways to improve operator performance and awareness at low downlink transmission rates. This can be affected by integrating synthetic information on orientation and MUAV status into the sensor image.
Author
Man Machine Systems; Pilotless Aircraft; Human Factors Engineering; Teleoperators

19970025421 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik, Brunswick, Germany
ROTORCRAFT-PILOT COUPLING: A CRITICAL ISSUE FOR HIGHLY AUGMENTED HELICOPTERS?
Hamel, Peter G., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Rotorcraft-pilot coupling (RPC) has became a critical issue for flight safety. Based on experience in the field of aircraft-pilot coupling (APC), definitions and limited prediction opportunities of three RPC categories are discussed. Time delay, rate-limiting elements and pilot manipulators of full-authority FbW/L flight control systems provide new potentials of unfavorable rotorcraft-pilot coupling phenomena. Some limited RPC flight test experience at AFDD and DLR is presented. Research requirements for soliciting RPV prevention methodologies and technologies are laid down. New flight test techniques prediction tools and advanced technologies are proposed to improve RPC immunity.
Author
Pilot Induced Oscillation; Aircraft Pilots; Flight Tests; Flight Control; Helicopters

19970026392 Institut Franco-Allemand de Recherches, Saint-Louis, France
ACTIVE HEARING PROTECTORS: NEW DEVELOPMENTS AND MEASUREMENT PROCEDURES
Buck, K., Institut Franco-Allemand de Recherches, France; Parmentier, G., Institut Franco-Allemand de Recherches, France; Jun. 1997; 6p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The need for active noise cancellation (ANC) hearing protectors in the armed forces is shown. A description of the systems that are actually commercially available and of the way that future systems may be designed is described. It is also presented, that the presently normalized evaluation procedures should be modified to suit better the new technology of active hearing protectors.
Author
Armed Forces; Noise Reduction; Ear Protectors; Hearing; Noise Injuries; Loudness; Sound Intensity; Human Factors Engineering

19970026393 Laboratoire de Medecine Aerospatiale, Bretigny-sur-Orge, France
LABORATORY EVALUATION OF HEARING AID DEVELOPED FOR COMBAT AVIATION *EVALUATION EN LABORATOIRE DE PROTHESES AUDITIVES DEVELOPPEES POUR L'AVIATION DE COMBAT*
Clere, J. M., Laboratoire de Medecine Aerospatiale, France; Ossard, C., Laboratoire de Medecine Aerospatiale, France; Grateau, P., Grateau (P.), France; Reynaud, G., Sextant Avionique, France; Jun. 1997; 8p; In French; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Man-machine dialogue is improved by the installation of new systems (viewfinder) on head-mounted equipment (helmet, mask, etc.). These systems make the equipment heavier and even render it dangerous due the Load factor. to make head-mounted equipment lighter, it was contemplated that one might replace the earphones with hearing aids, in other words, 'ear plugs' of lesser weight equipped with miniature transducers for the transfer of phonic messages.
Transl. by Schreiber
Helmets; Audio Equipment; Earphones; Human Factors Engineering; Weight (Mass); Voice Communication

19970026394 Mainz Univ., Inst. of Occupational-, Social- and Environmental Medicine, Germany
IMPAIRED NOISE-ATTENUATION OF AIRCREW HELMETS AND HEADSETS FOR COCKPIT PERSONNEL WHO WEAR GLASSES
Rose, D.-M., Mainz Univ., Germany; Welsch, H., Institute of Aviation Medicine, Germany; Pongratz, H., Institute of Aviation Medicine, Germany; Konietzko, J., Mainz Univ., Germany; Jun. 1997; 4p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Goggles significantly reduce the noise attenuation provided by hearing protection. The alteration of noise attenuation in 3 different helmets and one headset with 4 different spectacles was the object of this investigation. Sound pressure levels were measured inside the auditory canals of 11 candidates who were exposed to pink noise of 104 dB(lin) SPL with and without wearing the different types of spectacles and helmets. The mean noise attenuation of the headset and the helmet No 1 with separate ear-cuffs (SPH-4) was reduced in the mean up to 6 dB by glasses with thick horn-rimmed frames and less by glasses with thin metal frames. Helmets No 2 and No 3 (HGU-55 and an integrated helmet) provided only poor noise protection, but there was no further reduction of noise attenuation by wearing glasses. Headsets and helmets with separate ear-cuffs provided good noise protection. The reduction of noise attenuation with spectacles is significant depending on the thickness of the ear-piece. Thick horn-rims could potentially increase the risk of hearing impairment. If noise attenuation values are already poor (integrated helmet) glasses will not change the values much. to avoid hearing damage, only spectacles with thin frames should be worn by aircrews. In addition the visual field will also be enlarged.
Author
Noise Reduction; Earphones; Flight Crews; Goggles; Helmets; Design Analysis; Ear Protectors; Noise Injuries

19970026395 Naval Aerospace Medical Research Lab., Pensacola, FL United States
THE APPLICATION OF A PROPRIETARY SOUND-ATTENUATING TECHNOLOGY TO PASSIVE CIRCUMAURAL HEARING PROTECTOR DESIGN
Thomas, G. B., Naval Aerospace Medical Research Lab., USA; Maxwell, D. W., Naval Aerospace Medical Research Lab., USA; VanDyke, P. R., Naval Aerospace Medical Research Lab., USA; Jun. 1997; 6p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The USA Navy recently patented (U.S. Patent #5,400,296 296) a composite technology that significantly improves a base materials ability to attenuate acoustical energy, particularly low-frequency acoustical energy. Given our success in applying the technology to components used by the transportation industry, we decided to investigate the feasibility of applying the technology to materials useful in the fabrication of circumaural hearing protectors. The proprietary technology is based on maximizing characteristic acoustic impedance differences between the constituents of the composite material. Because each base material used in the construction of the various components comprising a circumaural earcup assembly generally possesses a different inherent characteristic acoustic impedance, specific composite formulas had to be derived for each component material. That is, empirically derived formulas were required for the earcup shell material (i.e., epoxy resin), the ear seal material (i.e., silicone rubber), the ear seal filler (i.e., silicone gel), and requisite adhesives (i.e., silicone sealers). Hearing protector components were fabricated, then modified if necessary, based on results from flat plate coupler tests. Concentrating on noise frequencies below 125 Hz, we were able to fabricate carcup components that were generally superior in noise attenuation to those currently in standard use. In some instances. performance on the flat plate coupler yielded attenuation gains (relative to standard issue hearing protectors) of about 20 dB (at 31.5 Hz, for example). Gains on human models below 125 Hz are in the 9-15 dB range. The weak link in the carcup assembly remains the

traditionally problematical car seal (and the inverse relationship between noise-attenuation effectiveness and user comfort and acceptance). New materials and designs are being investigated to optimize this component.
Author
Composite Materials; Ear Protectors; Noise Reduction; Design Analysis; Fabrication; Acoustic Attenuation; Human Factors Engineering

19970026396 Army Aeromedical Research Lab., Fort Rucker, AL United States
THE COMMUNICATIONS EARPLUG: A LOGICAL CHOICE FOR VOICE COMMUNICATIONS IN AIRCRAFT
Mozo, Ben T., Army Aeromedical Research Lab., USA; Ribera, John E., Brooke Army Medical Center, USA; Audio Effectiveness in Aviation; Jun. 1997; 10p; In English; See also 19970026380; Sponsored by Army Project Managers Office; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The U.S. Army aviator works in high levels of noise and routinely faces the challenge of effective voice communication. Existing aviator helmets, while adequate in providing hearing protection, do not provide the signal-to-noise ratio necessary to optimize in-flight voice communications. The Communications Earplug (CEP) is a small device worn by the aviator and provides significant improvements in hearing protection and communication performance. The CEP uses a miniature earphone transducer adapted to a replaceable foam earplug. Attenuation characteristics of the CEP are similar to those of other insert hearing protective devices and provide adequate protection in U.S. Army noise environments. Additional protection results when the CEP is worn with the aviator's helmet. The CEP is comfortable over a period of several hours and, in its current configuration, is considered highly acceptable by seasoned aviators and crewmembers. The CEP is easier to insert and seat in the outer ear canal than other insert protectors available through military channels. Speech intelligibility in simulated helicopter noise is significantly enhanced when using the CEP when compared to the standard SPH-4 and HGU-56/P aviator's helmets. CEP and active noise reduction (ANR) results are comparable in terms of speech intelligibility. However, there are several differences that should be considered before deciding which is the system of choice. The technology developed for CEP has wide-ranging application in the military and can easily be adapted to communication needs in the civilian community. The CEP is an inexpensive device that can enhance air and ground crewmember voice communications in the operational environment, and should be positively considered for inclusion into all aircraft and vehicular communication helmets as a battlefield multiplier for the 21st century.
Author
Aircraft Pilots; Earphones; Voice Communication; Noise Reduction; Helmets; Active Control; Hearing; Ear Protectors; Auditory Perception; Audio Equipment

19970026397 Defence and Civil Inst. of Environmental Medicine, North York, Ontario Canada
CONSTRAINTS IN THE APPLICATION OF PERSONAL ACTIVE NOISE REDUCTION SYSTEMS
Crabtree, R. B., Defence and Civil Inst. of Environmental Medicine, Canada; Jun. 1997; 6p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Active Noise Reduction (ANR) systems built into personally-worn headsets and helmets, when properly designed and carefully fitted, have shown considerable potential for reducing noise exposure and improving the listening conditions under which auditory tasks are carried out in military operations. Performance limitations have been identified in certain devices, however. Some have a tendency to overload easily or to cease operating under adverse conditions, and others become unstable when the seal around the ear is broken. Recent findings indicate strongly that proper fitting around the ear is a functional necessity for satisfactory ANR operation. This is particularly true of units having a low tolerance to overloading and those which continue to operate in the infrasound frequency range. As a consequence, the function of any ANR system must be understood within the context of its intended operating environment in order to estimate whether the system will perform satisfactorily.
Author
Noise Reduction; Earphones; Ear Protectors; Hearing; Auditory Perception; Military Operations; Human Factors Engineering

19970026398 Centre d'Enseignement et de Recherches de Medecine Aeronautique, IMASSA, Bretigny, France
ASSESSMENT OF ACTIVE NOISE REDUCTION HEARING PROTECTORS: NOISE ATTENUATION AND SPEECH INTELLIGIBILITY *EVALUATION DE CASQUES A REDUCTION ACTIVE DE BRUIT: PROTECTION AUDITIVE ET INTELLIGIBILITE*
Pellieux, L., Centre d'Enseignement et de Recherches de Medecine Aeronautique, France; Sarafian, D., Centre d'Enseignement et de Recherches de Medecine Aeronautique, France; Reynaud, G., Sextant Avionique, France; Jun. 1997; 20p; In French; See also 19970026380; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Hearing protection offered by current pilot helmets is far to be fully satisfying as shown by the large number of hearing losses observed in military aviators at retirement age. Due to the poor intelligibility of communication channels the sound volume has to be significantly increased which adds a dangerous auditory stressor. Eight hearing protectors such as commercially available active noise reduction (ANR) headsets and prototype helmets, equipped with ANR earshells, were assessed in order to estimate their efficacy for both noise attenuation and improvement on speech intelligibility. The assessment was based on original experimental protocols including abnormal conditions, objective measurement of both passive and active attenuations by the MIRE method, subjective prediction of intelligibility by measuring the Speech Transmission Index, and its subjective evaluation through CVC tests. Realistic jet and helicopter noisy environments and a pink noise have been used to perform the tests. The results obtained with the various systems assessed are presented and discussed.
Author
Noise Reduction; Aircraft Pilots; Hearing; Ear Protectors; Noise Injuries; Speech Recognition; Earphones; Auditory Fatigue

19970026400 Institute for Human Factors TNO, Soesterberg, Netherlands
PERSONAL ACTIVE NOISE REDUCTION WITH INTEGRATED SPEECH COMMUNICATION DEVICES: DEVELOPMENT AND ASSESSMENT
Steeneken, H. J. M., Institute for Human Factors TNO, Netherlands; Verhave, J. A., Institute for Human Factors TNO, Netherlands; Jun. 1997; 8p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Active noise reduction is a successful addition to passive earde-fenders for improvement of the sound attenuation at low frequencies. Assessment methods are discussed, focused on subjective and objective attenuation measurements, stability, and on high noise level applications. Active noise reduction systems are suitable for integration with an intercom. For this purpose the intelligibility in combination with environmental noise is evaluated. Development of a system includes the acoustical design, the feedback amplifier, and the speech input facility. An example of such a development is discussed. Finally the performance of some commercial systems and a laboratory prototype are compared.
Author
Communication Equipment; Noise Reduction; Voice Communication; Acoustic Attenuation; Speech Recognition; Ear Protectors; Design Analysis

19970026401 National Research Council of Canada, Ottawa, Ontario Canada
ADAPTIVE ACTIVE NOISE REDUCTION HEADSET FOR HELICOPTER AIRCREW
Pan, G. J., National Research Council of Canada, Canada; Brammer, A. J., National Research Council of Canada, Canada; Crabtree, R. B., Defence and Civil Inst. of Environmental Medicine, Canada; Jun. 1997; 6p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The feasibility of applying adaptive active noise reduction (ANR) to a communication headset has been explored by applying digital feedforward control to a headset designed for helicopter aircrew. A miniature microphone was mounted on the outside of one circumaural earmuff to provide a reference signal, while the original microphone and earphone located within the volume enclosed by the earcup of a commercial ANR headset were retained to provide an 'error' signal and the corrective sound field, respectively. The signals were digitized and processed in real time by a TMS320C31 digital signal processor

operating at 40 MHz. The performance of the apparatus has been evaluated in a reverberant room using a recording of Sea King helicopter noise at the aircrew position. The noise was replayed so as to reproduce the sound pressure levels measured in the helicopter during hover. Both noise spectrum and level were confirmed by one-third octaveband analysis. For active control, the helicopter noise was band-limited to from 10 to 1000 Hz. When tested on five subjects, the apparatus controlled the noise at the ear within this frequency range, and the control system was stable. The noise reduction recorded at the error microphone, i.e., close to the ear canal entrance, was in excess of 10 dB from 16 to 300 Hz for all subjects, and ranged from 10 to 26 dB at the rotor blade passage frequency (16 Hz), and from 10 to 20 dB at frequencies up to 200 Hz, depending on the subject. The differences in ANR experienced by the subjects are believed to be associated with variations in the fit of the headset, and remain the subject of continuing research.
Author
Feedforward Control; Digital Systems; Active Control; Noise Reduction; Aircraft Noise; Earphones; Flight Crews; Microphones; Real Time Operation; Signal Analyzers; Human Factors Engineering; Design Analysis

19970026402 Army Research Lab., Human Research and Engineering Directorate, Fort Monmouth, NJ United States
EFFECTS OF ACTIVE NOISE REDUCTION IN ARMOR CREW HEADSETS
Anderson, B. Wayne, Army Research Lab., USA; Garinther, Georges R., Army Research Lab., USA; Jun. 1997; 6p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The armor environment, like that of aviation, makes communication difficult and often produces a hearing loss in the crewmembers. In an attempt to improve this situation, the Army is presently fielding tankers' helmets with Active Noise Reduction (ANR) as a part of the Vehicular Intercommunications System (VIS). A number of studies were conducted to evaluate the effectiveness of ANR for the armor environment. In-the-ear noise level measures were done and speech intelligibility tests conducted. For armored vehicles producing noise levels of 114 dB(A), these helmets reduce the noise at the ear to 83 dB(A) when the intercommunication system is not keyed, 90 dB(A) when the system is keyed, and 94 dB(A) when the system is keyed with a person talking over the system. This is an improvement in noise reduction of about 17 dB(A) compared to the helmets presently being used. This improved noise attenuation has increased speech intelligibility from 68% to 89%. According to previous studies, such an improvement can be equated to a 25% increase in successfully accomplished armor missions. Incorporation of ANR into these helmets has increased low frequency attenuation by up to 13 dB above the passive attenuation of these helmets. At frequencies greater than 800 Hz, ANR does not provide any additional attenuation above the passive attenuation. The attenuation produced by these new helmets has increased the allowable daily exposure time in armored vehicles from 20 minutes to 12 hours.
Author
Noise Reduction; Active Control; Auditory Defects; Voice Communication; Earphones; Armor; Military Vehicles; Helmets; Speech Recognition

19970026403 Armstrong Lab., Bioacoustics and Biocommunications Branch, Wright-Patterson AFB, OH United States
SPECIAL APPLICATIONS OF ACTIVE NOISE REDUCTION HEADSETS
McKinley, Richard L., Armstrong Lab., USA; Morris, Linda J., Armstrong Lab., USA; Nixon, Charles W., Armstrong Lab., USA; Jun. 1997; 4p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The growth of Active Noise Reduction (ANR) headset technology has accelerated over the past five years. The applications for normal hearing listeners are extensive and the potential for use by persons with hearing loss is excellent. The primary goal of ANR headsets is to reduce the level of the noise at the ears thereby reducing the probability of noise induced effects on hearing and on voice communications. In November 1995, a specially modified ANR headset was demonstrated for users with varying degrees of hearing loss. Most ANR headset systems in operation today are used in aviation associated applications where many of the users have mild to moderate hearing loss. This paper describes the sound attenuation and speech communications performance of both normal and modified ANR headset technology with both normal and hearing impaired users. The limitations and advantages are discussed as well as what can be expected from both standard and modified ANR headset systems.
Author
Voice Communication; Noise Reduction; Earphones; Hearing; Auditory Perception; Acoustic Attenuation

19970026404 Psycho-Linguistic Research Associates, Menlo Park, CA United States
ACTIVE NOISE REDUCTION FLIGHT TESTS IN MILITARY HELICOPTERS
Simpson, Carol, Psycho-Linguistic Research Associates, USA; King, Robert, Defence Science and Technology Organisation, Australia; Jun. 1997; 18p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

US Army Aeroflightdynamics Directorate (AFDD), in collaboration with AS Aeronautical and Maritime Research Laboratory (AMRL), has conducted flight tests in a range of military helicopters to determine the potential benefit of active noise reduction (ANR) earcups developed by the UK's Defense Research Agency (DRA) for military aircrew. Test data include (a) acoustic attenuation characteristics, (b) speech intelligibility, (c) aircrew ratings of cockpit speech intelligibility, clarity, and attention demand for speech message recognition, and (d) ratings of the suitability of ANR for operational use. Test aircraft in which data were collected include American NAH-1S (Cobra), UH-1H (Huey), OH-58D (Kiowa), AH-64A (Apache), EH-60 (Blackhawk), and Australian S-70B-2 (Seahawk) and S-70A-9 (Black Hawk). Results show that the DRA ANR system effectively reduced the level of low frequency noise (less than 800 Hz) and reduced overall at-ear sound pressure levels (SPL's) by around 10 dB. Results also indicate that ANR substantially increases speech intelligibility, reduces the level of attention pilots must use to understand speech communications, works with onboard weapons firing noise, allows pilots to hear familiar audio cues necessary for aircraft situational awareness, and functions without failure in training and actual combat conditions. With the DRA ANR system, speech intelligibility meets the exceptionally high intelligibility criteria as defined in MIL-STD 1472 for operational systems, providing the speech intelligibility needed to ensure that pilots and soldiers communicate tactical information accurately.
Author
Acoustic Attenuation; Noise Reduction; Military Helicopters; Flight Crews; Ear Protectors; Speech Recognition; Flight Tests

19970026405 Salford Univ., Dept. of Acoustics and Audio Engineering, United Kingdom
NEXT GENERATION ACTIVE NOISE REDUCTION SYSTEMS
Darlington, P., Salford Univ., UK; Rood, G. M., Defence Research Agency, UK; Jun. 1997; 6p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Active techniques for attenuating the sound pressure levels at the ears of aircrew are examined. Conventional Active Noise Reduction (ANR) systems are reviewed. Their performance is shown to be constrained by their essential 'feedback' architecture. ANR systems which avoid the feedback path are introduced and the performance of a new active noise reduction system is reported. The new system is demonstrated to offer such attenuation of noise that hearing damage risk is significantly reduced and operational performance enhanced.
Author
Noise Reduction; Acoustic Attenuation; Sound Pressure; Hearing; Flight Crews; Auditory Fatigue; Ear Protectors

19970026406 Rigshospitalet, Dept. of Otolaryngology, Copenhagen, Denmark
AIRCRAFT NOISE PROFILES AND THE EFFICIENCY OF NOISE PROTECTION DEVICES IN THE ROYAL DANISH AIR FORCE
Vesterhauge, S., Rigshospitalet, Denmark; Osterhammel, P. A., Rigshospitalet, Denmark; Rasmussen, A. Norby, Rigshospitalet, Denmark; Oldenburg, J. N. S., Royal Danish Air Force, Denmark; Jensen, E. S., Royal Danish Air Force, Denmark; Jun. 1997; 6p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Except for being hazardous to the function of the ear itself, noise has a lot of unpleasant non-organic capabilities. It is annoying, noise interferes with performance and efficiency, and it interferes with

communication. No matter what we do, we all have to live with and accept certain levels of noise. This, indeed, counts for aviation too. It has been told, that when Louis Bleriot in 1909 flew from France to England, the noise from his 25 HP engine heard from the ground by those fortunate enough to witness this historic event, was probably 20 to 30 dB louder than the noise reaching the ground from a current jet aircraft. This was caused by the fact that Bleriot flew very much lower than modern aircraft. So, due to simple physical laws, the closer you are to a noise source. the more you are exposed. and those closest to an aircraft are those working in it or outside the plane. In the air force and in other flying units of our defense, personnel is exposed to high levels of noise. The purpose of the present study, is simply to map, in a comparable way the noise impact on personnel working at different positions in relation to aircraft used by the Danish defense - to establish the efficiency of different noise protection devices used by personnel working at different positions - and finally to advice the proper authorities concerning the proper use of noise protection devices in order to avoid as much as possible the harmful effects of aircraft noise as described above.
Author
Aircraft Noise; Ear Protectors; Noise Reduction; Human Factors Engineering; Auditory Fatigue; Occupational Diseases

19970029371 Defence Science and Technology Organisation, Air Operations Div., Salisbury, Australia
A GENERIC ARCHITECTURE FOR CREW ASSISTANT SYSTEMS
Urlings, Pierre J. M., Defence Science and Technology Organisation, Australia; Zuidgeest, Rene G., National Aerospace Lab., Netherlands; Jul. 1997; 12p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A crew assistant is an on-board automated system that supports an aircraft crew in performing its tasks. Aircraft crews are currently confronted with numerous displays and complex controls in their cockpit. An overwhelming amount of multi-source data is offered while simultaneously control over the aircraft and its systems has to be maintained. This may lead to situations of high workload in which non-optimal decisions are made. Crew assistant systems are planned to reduce this problem and hence improve efficiency and flight safety. They are expected to rely heavily on Advanced Information Processing (AIP) technologies to organize data and control flow in such a way that the crew is provided with concise and relevant information. At the same time the crew's control efforts will be considerably reduced. This will enable the crew to concentrate on essentials and to make decisions more effective Several developments exist in this area. Pioneer programmes are the US 'Pilot's Associate' the British 'Mission Management Aid' the French 'Copilote Electronique' and the German 'Cockpit Assistant System.' These programs go by different names but all aim at the automation of routine tasks and the provision of effective aids to the crew problem solving and task management. The architectures developed in these programmes have many elements in common but suggest a more generic architecture. Another common element of these programmes is that they consider AIP as key technology for their successful implementation. AIP provides technologies able to handle the complex interaction between crew, crew assistant, aircraft systems and sensors. This paper focuses in particular on these two aspects: a generic crew assistant architecture and the application of AIP technology. In section 2 the operational environment is described in which a crew assistant is to be embedded. Section 3 introduces a generic crew assistant architecture which is independent of any type of aircraft or operation. Section 4 proposes the application of AIP in general and of multi-agent systems in particular as a key technology for successful implementation of a crew assistant. Throughout the paper, the crew assistant is illustrated by an application of a single-pilot military aircraft, but the concept is also relevant to multi-crew or civil aircraft.
Author
Information Systems; Information Flow; Flight Safety; Flight Operations; Flight Crews; Display Devices; Data Processing; Civil Aviation; Cockpits

19970029372 Elektroniksystem- und Logistik G.m.b.H., Avionics-Fixed Wing Aircraft, Munich, Germany
PERSPECTIVES OF CREW ASSISTANCE IN MILITARY AIRCRAFT THROUGH VISUALIZING, PLANNING AND DECISION AIDING FUNCTIONS
Schulte, Axel, Elektroniksystem- und Logistik G.m.b.H., Germany; Kloeckner, Wolfgang, Elektroniksystem- und Logistik G.m.b.H., Germany; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Due to increasing demands put on crews of military aircraft, effective cockpit systems will be required in order to reduce workload and to improve crew performance. This paper presents various approaches to crew assistance in tactical flight missions. The underlying tasks are tactical decision making, low-level flight planning and flight guidance. The integration of the Tactical Situation System as part of a knowledge based crew assistant and a flight guidance display system incorporating sensor and synthetic vision components offer a promising solution to improve the situational awareness of the crew. Respective prototypes have been successfully tested and evaluated in a simulated environment as well as by flight trials.
Author
Knowledge Based Systems; Human Performance; Guidance Sensors; Flight Plans; Flight Crews; Cockpits

19980003894 Army Aeromedical Research Lab., Aircrew Protection Div., Fort Rucker, AL United States
HEAD INJURY RISK IN US ARMY ROTARY-WING MISHAPS: CHANGES SINCE 1980
Shannon, Samuel G., Army Aeromedical Research Lab., USA; Albano, John P., Army Aeromedical Research Lab., USA; Licina, Joseph R., Army Aeromedical Research Lab., USA; Nov. 1997; 10p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Over the past several decades, data have been collected on U.S. Army aircraft mishaps defining the environment within an aircraft during a mishap, injuries suffered by the occupants, and the cause (or causes) of the mishap, if known. An analysis of these data indicates 60% of the occupants are injured, one-third fatally, if the mishap concludes with the aircraft impacting the ground. More significantly, despite improvements in helicopter design, restraint systems, and personal protective equipment, 68% of all fatalities had at least one fatal injury to the head. After adjusting for differences in mishaps, including the aircraft series, and the occupant's station within the aircraft, the authors concluded that an occupant's injury risk in a helicopter mishap had decreased significantly between 1980-84 and 1990-94. One factor in this was a decline in the risk of head injury, which declined by 50%. Injury risks to the face and brain, critical anatomical regions of the head, also showed a significant decline. Risks of injury to the neck, torso, and upper extremities were not significantly different between the two time intervals. Although the authors could not identify causative factors with clear implications for preventive strategies, the proportion of new, crashworthy helicopters in the U.S. Army fleet have risen steadily since 1980 and a new flyer's helmet with improved impact protection, the SPH-4B, was fielded by the U.S. Army in the 1990's.
Author
Aircraft Accidents; Risk; Crashes; Helicopters; Crash Injuries

19980003895 Royal Air Force, School of Aviation Medicine, Farnborough, United Kingdom
STANDARDS FOR PROTECTIVE HELMETS
Glaister, D. H., Royal Air Force, UK; Nov. 1997; 4p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Undoubtedly, the protection afforded by helmets for sporting activities, the workplace and the military has improved over the years, but at a somewhat modest pace. Many published reports attest to the benefits of helmet wear in most applications, but equally show that brain damage and death can still occur despite the wearing of approved headgear, and not always under conditions of massive 'unsurvivable' impact. A better understanding of the mechanics of brain injury, the continued application of accident data, the development of more appropriate helmet test methods and the availability of new materials, together with a growing public awareness of safety,

should allow the makers of standards to demand further improvements from helmet manufacturers and ensure a continuing fall in morbidity and death from head injury.
Derived from text
Helmets; Protection; Head (Anatomy); Crash Injuries; Standardization; Product Development

19980003897 Army Aeromedical Research Lab., Fort Rucker, AL United States
MASS REQUIREMENTS FOR HELICOPTER AIRCREW HELMETS
McEntire, B. Joseph, Army Aeromedical Research Lab., USA; Shanahan, Dennis F., Army Aeromedical Research Lab., USA; Nov. 1997; 6p; In English; See also 19980003879; Sponsored in part by Program Managers for Comanche; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Helicopter aircrew helmets are becoming more sophisticated with increased mission requirements. This increase results in additional mass being supported on the aircrew's head. Ultimately, there is a limit to how much mass can be supported by the aircrew without increasing the fatigue rates and neck injury risk in accidents. This paper reviews the past mass property requirements of Army helicopter helmets. Current requirements for the RAH-66 Comanche helmet are also detailed with the rationale for their derivation.
Author
Helmets; Center of Mass; Mass Distribution; Structural Design Criteria; User Requirements

19980003898 Simula, Inc., Phoenix, AZ United States
INFLATABLE RESTRAINT SYSTEMS FOR REDUCING HEAD INJURY
Zimmermann, Richard E., Simula, Inc., USA; Yaniv, Gershon, Simula, Inc., USA; Nov. 1997; 14p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Inflatable restraint systems, in the form of "air bags," are widely recognized as an effective means of reducing crash injury in automobiles. In order to provide similar crash injury protection in both commercial and military aircraft, a variety of inflatable restraint systems are now being developed. For commercial aircraft, the Passenger Air Bag System, (PABS) will provide protection for occupants in seats positioned behind bulkheads, galleys, or restrooms. The first application of PABS will be on the Jetstream J-41 aircraft. For military aircraft, a number of inflatable restraint systems are also being developed for the special conditions found in their crewstations. In addition to the Cockpit Air Bag System (CABS) that has similarities to automotive air bags, there is the Inflatable Body and Head Restraint System (IBAHRS) for use in some attack helicopters, and the Inflatable Tubular Structure (ITS) for use in small helicopters.
Author
Air Bag Restraint Devices; Crash Injuries; Protection; Head (Anatomy); Product Development

19980003899 Army Aeromedical Research Lab., Fort Rucker, AL United States
SIMULATIONS OF HEAD STRIKES IN HELICOPTERS AND THE ROLES OF RESTRAINTS, SEAT STROKE AND AIRBAGS ON THEIR REDUCTION
Alem, Nabih M., Army Aeromedical Research Lab., USA; Beale, David G., Auburn Univ., USA; Mobasher, Amir A., Universal Energy Systems, Inc., USA; Brozoski, Frederick T., Universal Energy Systems, Inc., USA; Nov. 1997; 8p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Injuries from head strikes remain the leading cause of fatalities in U.S. Army helicopter mishaps. The roles of the restraint system, energy absorbing seat stroke and airbags in preventing or reducing the severity of head strikes are explored in this paper using mathematical simulations. Starting with a baseline simulation of an actual AH-64 survivable mishap in which the pilot received fatal basilar skull injury, the effects of three parameters were examined: timing of inertia reel locking, stroking of the energy absorbing seat, and the presence of an airbag mounted at the instrument panel. Results of the simulations suggested that delay of inertia reel in locking at the appropriate time together with obstruction of seat stroking may have caused the pilot's head to strike the glare shield. When a head strike was unavoidable, simulations indicated that an airbag would have reduced its severity.
Author
Air Bag Restraint Devices; Computerized Simulation; Crash Injuries; Damage Assessment; Physiological Effects; Biodynamics

19980003900 BTS Consulting Engineers, Windsor, Ontario Canada
ADDRESSING FRONT ROW HIC REQUIREMENTS IN COMMERCIAL AIRPLANES
McCarthy, J. R., BTS Consulting Engineers, Canada; Yang, K. H., Wayne State Univ., USA; Shanahan, M. T., BTS Consulting Engineers, Canada; King, A. I., Wayne State Univ., USA; Nov. 1997; 6p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Changes to the Federal Aviation Administration (FAA) regulation regarding occupant crash protection in commercial airplanes has created new design considerations for each occupant position. In particular, addressing front row seating positions to meet the head injury criteria can be a challenging design assignment involving numerous considerations. Various design approaches to meet this requirement are discussed. Particular attention is given to the articulating seat pan approach. Results of prototype testing are presented with recommendations regarding further development.
Author
Commercial Aircraft; Head (Anatomy); Protection; Impact Resistance; Seats; Dynamic Tests

19980003901 General Motors Corp., Safety Research Dept., Warren, MI United States
INVESTIGATION OF INDY CAR CRASHES USING IMPACT RECORDERS
Melvin, J. W., General Motors Corp., USA; Baron, K. J., General Motors Corp., USA; Little, W. C., General Motors Corp., USA; Pierce, J., General Motors Motorsports, USA; Trammell, T. R., Championship Automobile Racing Teams Safety Team, USA; Nov. 1997; 20p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes the initial phases of an ongoing project in the GM Motorsports Safety Technology Research Program to investigate Indy car crashes using an on-board impact recorder as the primary data collection tool. The development of a database consisting of crash investigation data patterned after national highway crash databases is discussed. The data gathered and coded includes track and incident scene information, vehicle damage, and driver injuries, as well as the vehicle decelerations measured by the impact recorder. The paper discusses the development of specifications for the impact device, the selection of the specific recorder and its implementation on a routine basis in Indy car racing. The results from incidents that produced significant data during the 1993, 1994 and 1995 racing seasons are summarized.
Author
Data Acquisition; Data Bases; Automobile Accidents; Data Recorders; Accident Investigation; Impact Damage

19980003902 Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Crash Safety Research Center, Delft, Netherlands
MODELLING HEAD INJURY COUNTERMEASURES: A 3D HELMET MODEL
Brands, D. W. A., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Thunnissen, J. G. M., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Wismans, J. S. H. M., Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Netherlands; Nov. 1997; 12p; In English; See also 19980003879; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A three dimensional Finite Element Model of an existing full-face motorcycle helmet mounted on a headform has been developed. Material parameters were obtained from literature data and from component tests. The model is validated by simulating impacts at different locations using the headform acceleration time histories. From this it can be concluded that the headform response is predicted in a realistic way. The simulations showed two phenomena that influence the headform response, i.e. the behaviour of the material between the headform and the point of impact, and the dynamic

response of the outer regions of the outer shell. It is believed that the current model describes most of the phenomena observed during an impact and, therefore, is suitable for future optimization studies. The application of the current model is limited to impacts on a flat anvil at points in the median plane of the headform. Recommendations for further model enhancements will be presented.
Author
Dynamic Response; Helmets; Three Dimensional Models; Crash Injuries; Impact Tests; Computerized Simulation

19980018040 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
3-D SURFACE ANTHROPOMETRY: REVIEW OF TECHNOLOGIES
L'ANTHROPOMETRIE DE SURFACE EN TROIS DIMENSIONS: EXAMEN DES TECHNOLOGIES
Dec. 1997; 192p; In English
Report No.(s): AGARD-AR-329; ISBN 92-836-1069-5; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

This document, in seven chapters, describes the dramatic changes taking place in the field of anthropometry due to advances in 3-D imaging technology. Chapter I explains how 3-D technology can overcome many of the limitations of traditional anthropometry; Chapter II discusses applications for 3-D anthropometry; Chapter III compares traditional and 3-D data collection methods; Chapter IV discusses ways to display 3-D images for users of the data; Chapter V addresses database management issues; Chapter VI explains how the latest user interface design techniques can help users of 3-D data; and Chapter VII examines 3-D data standardization issues and provides a list of current standards for 3-D data.
Author
Anthropometry; Three Dimensional Models; Technologies; Reviewing; Data Acquisition; Data Management; Telecommunication

19980033531 Smiths Industries Aerospace and Defence Systems Ltd., Cheltenham, United Kingdom
ASPECTS OF THE CREW INTERFACE FOR MISSION SYSTEMS
Ovenden, C. R., Smiths Industries Aerospace and Defence Systems Ltd., UK; Wykes, K. M., British Aerospace Defence Ltd., UK; Semple, W. G., British Aerospace Defence Ltd., UK; Normanton, T. H., Smiths Industries Aerospace and Defence Systems Ltd., UK; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 6p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The challenge for future mission systems is to produce affordable solutions that provide the desired levels of operational effectiveness. This will be achieved by a system that enables the operator to be in ultimate control of the mission system through a manageable workload and an appropriate level of situational awareness. The crew interface is therefore vital to exploiting the full capabilities of the platform under control. The crew interface can be enhanced by the thoughtful application of technology. to be affordable however, the technology must be carefully matched with requirements. At all stages of the design, including research phases, consideration has to be given to a careful harmonisation of the capabilities of the human, the hardware and the software. To be effective, the design must evolve from the beginning through co-operation between the designers, the implementors and the users. Recognizing the benefits of extending this approach into the research phase, a collaboration has been established between British Aerospace Military Aircraft and Smiths Industries Aerospace to explore aspects of the crew interface for mission systems. This paper discusses the goals for an affordable and effective future mission system and the approach being taken to achieve these goals.
Derived from text
System Effectiveness; Crews; Human-Computer Interface; Computer Programs; Workloads (Psychophysiology)

19980033538 British Aerospace Defence Ltd., Preston, United Kingdom
COCKPIT USABILITY - A DESIGN CHECKLIST
Turner, John, British Aerospace Defence Ltd., UK; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 8p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

'Usability' represents the degree of help or hindrance provided to the pilot or crew member as they attempt to complete the operational missions with which they may be tasked; it also acknowledges the financial/technological realities against which designs are developed. The factors which impact cockpit and system usability, some of the steps necessary to achieve it, and suggested items for inclusion in a usability design checklist are discussed.
Derived from text
Cockpits; Pilots; Crews; Constraints

19980033540 Armstrong Lab., Crew Systems Directorate, Wright-Patterson AFB, OH United States
THE SHAPE OF THINGS TO COME: REVOLUTION IN ENGINEERING ANTHROPOMETRY
Robinette, Kathleen M., Armstrong Lab., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 8p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Even after discovering the world was not flat, map makers were limited to representing our three-dimensional(3-D) world on a flat piece of paper. This was fine for small regions. For large regions, however, distortions became obvious; continents were misshapen, enlarged or shrunken. Like the earth, the human body is covered with ridges, hills and valleys and is anything but flat. Scientists attempting to map the body face the same difficulty with distortions that cartographers do. For engineering purposes, researchers measure the 3-D body, but until now they have used only one- or two-dimensional tools. They have been forced to change back and forth from 3-D to 2-D to create the products. This paper describes the design impact of the limitations with traditional tools for human body measurement and illustrates the future potential of 3-D surface anthropometry technology on the engineering of aerospace systems.
Derived from text
Aerospace Systems; Anthropometry; Continents; Exploration

19980035014 Flight Test Squadron (40th), DOOB, Eglin AFB, FL United States
REDUCTION OF AIRCREW WORKLOAD THROUGH THE USE OF INS/GPS WHILE EMPLOYING STANDOFF WEAPONS
Stolz, Earl W., Flight Test Squadron (40th), USA; Kosan, Keith J., Flight Test Squadron (40th), USA; Dec. 1997; 12p; In English; See also 19980035004; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Modern fighter aircraft are capable of unprecedented attack accuracy. However, the risk associated with close-in delivery against well-defended targets is often high. As a result, current tactics call for delivery of precision-guided munitions from increased standoff ranges. The AGM-130 was designed to fill this need. The AGM-130 evolved from the GBU-15 family of glide bombs and is equipped with a rocket motor to increase standoff range. With the increase in launch ranges came an increased workload due to difficulty locating targets within the seeker's Field of View (FOV). A launch heading offset or crosswind could require the Weapon Systems Officer (WSO) to scan a large area to locate both the target itself and any required waypoints. The MidCourse Guidance (MCG) program is an enhancement designed to address this difficulty by decreasing workload with an autonomous guidance capability in the midcourse portion of the flight and the ability to point the seeker at the target. The objective of the AGM-130 MCG test program is to evaluate the benefits associated with reduction of aircrew workload with the introduction of an Inertial Navigation System (INS) that is position- and velocity-aided by the Global Positioning System (GPS). This paper will discuss flight test techniques and results obtained from the Phase I test program, which focused on initial integration efforts using profiles to attack vertical targets. Phase 11 will address the capability to attack horizontal targets and is currently being tested. A secondary objective of demonstrating the advantages of guidance using Wide Area GPS Enhancement (WAGE) corrections was also accomplished. Testing involved a series of ground functional tests, captive carries in which the aircraft flew the weapon's profile, and three live launches. The stated goal of the MCG program is to ensure that the target appears in the seeker's wide FOV at 15 seconds time-to-go 95% of the time. In all cases this criteria was met. Additionally, the target was within the narrow FOV 100% of the time. Using the Subjective Workload Assessment Technique (SWAT) in a head-to-head comparison with a non-MCG-guided AGM-130, a 25% reduction of WSO workload was demonstrated.

Subjective assessments of the value of the MCG modification were made using aircrew questionnaires and a modified Cooper-Harper Scale.
Author
Flight Crews; Fighter Aircraft; Workloads (Psychophysiology); Global Positioning System; Field of View; Distance

19990007858 FGAN, Research Inst. for Electronics and Mathematics, Wachtberg-Werthhoven, Germany
INVESTIGATION OF HUMAN PERFORMANCE MONITORING AN IR-CAMERA VIEW FROM AN UNMANNED TACTICAL AIRCRAFT
Gaertner, Klaus-Peter, FGAN, Germany; Krueger, Walther, FGAN, Germany; Jul. 1998; 6p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Man-machine system performance on target designation and tracking tasks can be influenced by the design of the manual control subsystem including characteristics of the control device. An experimental set-up simulates the control station of a human operator monitoring a computer display which shows the stabilized TV-camera view out of an unmanned aerial vehicle flying at low altitude. Using a handgrip controlstick the operator can control the direction of the missile's camera to facilitate the designation of a target. After "lock on", further tracking of the target is made by an automatic tracking system. The operator has to monitor the tracker function and to make corrections if necessary. Target designation by the operator becomes a critical task because the camera system has a narrow field of view to enhance good recognition. Thus target images move towards display edges in a short time. So the target designation task has to be fast and reliable. to achieve near optimum operator performance three different types of control sticks are used and compared in an experiment: (1) a moveable stick (displacement), (2) a stiff stick (hybrid force), and (3) an unmoveable stick (pure force). Additionally the sensitivity, i.e. the gain of the control signal, is being varied including a non-linear relationship. Results of a test series conducted comparing linear and non-linear control gain showed no significant differences on performing the target acquisition task.
Author
Control Systems Design; Man Machine Systems; Manual Control; Operator Performance; Human-Computer Interface; Control Simulation; Control Sticks

19990014371 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
INTEGRATION OF TECHNOLOGIES FOR CLOSED COCKPITS
Timmers, H., Advisory Group for Aerospace Research and Development, France; Helps, K., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 78; In English; See also 19990014353; Copyright Waived; Avail: Issuing Activity; Abstract Only; Abstract Only

All future aerial missions are threatened by directed energy weapons (DEWS) or flash devices. The availability of rather inexpensive blinding flash devices can soon significantly hinder or even prevent the effective use of air power. In order to protect aircrews and enable them to successfully continue the mission the concept of closed cockpits will be an important means to overcome these threats. Processing capabilities which will be available in the near to midterm future make the realization of closed cockpits feasible. Still, the closed cockpit impose some severe problems which must be solved in order to maintain crew awareness under all circumstances and in all phases of flight. To name only a few of them, problems associated with synthetic vision, sensor displays and sensor integration or pilot interaction with all aircraft systems must be solved to make the closed cockpit concept operational viable. It must be proven, that sensors can be built, which work reliably under all conditions (including massive counter measures), that all available data can be fused together and that all these sensors can be integrated in a way to give results which can be trusted and effectively communicated to the aircrew. The realization of closed cockpits is a task, which requires contributions from many other technology fields, hence, it works as a technology driver also outside it direct field of application. The benefits of the closed cockpit will be the ability to perform aerial missions also in presence of a new class of threats successfully.
Author
Cockpits; Pilot Support Systems; Multisensor Fusion; Systems Integration; Flight Management Systems

19990032479 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
A DESIGNER'S GUIDE TO HUMAN PERFORMANCE MODELLING
LA MODELISATION DES PERFORMANCES HUMAINES: MANUEL DU CONCEPTEUR
A Designer's Guide to Human Performance Modelling; December 1998; 170p; In English; See also 19990032480 through 19990032490 Report No.(s): AGARD-AR-356; ISBN 92-836-1077-6; Copyright Waived; Avail: CASI; A08, Hardcopy; A02, Microfiche

Working Group 22 was convened in 1995, jointly sponsored by the Aerospace Medical Panel and the Flight Vehicle Panel to investigate the use of Human Performance Models within the specification, procurement, design, qualification and certification of military systems. In particular the group focused on the selection, application and use of HPMs by the system designer. An expert system approach was selected to ensure that the designer considered all the relevant factors when selecting a new model or tool. This was implemented using a commercially available expert system shell. The user is asked to select options that most closely describe his resources and requirements and the Human Operator Modelling Expert Review (HOMER) then rank-orders the HPMs in its database and suggests the most appropriate model. The group carried out some walkthroughs of existing models/tools to demonstrate typical uses in the analysis of specific issues. These are included as case studies. These were included to give potential users some insight into the ease or complexity of use in order to evaluate the required aspect of human performance. In addition the group also considered the model developer community by examining the limitations of existing models, commercial implications and usability issues in order to guide any future development.
Author
Human Performance; Expert Systems; Models; Human Factors Engineering; Man Machine Systems; Systems Engineering; Operations Research

19990032483 Defence Evaluation Research Agency, Aircraft Test and Evaluation, Boscombe Down, United Kingdom
APPLICATION OF AN ANTHROPOMETRIC TOOL TO COCKPIT LAYOUT
Burrett, Gretchen, Defence Evaluation Research Agency, UK; A Designer's Guide to Human Performance Modelling; December 1998, A3-1 - A3-4; In English; See also 19990032479; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Anthropometric tools are used to assess human interaction with workplace layout in terms of fit, reach and vision. As humans do not come in a standard size, these tools address the range of potential users, from very small to very large. This paper provides an example of how Anthropometric tools can be used to help optimise cockpit layout. Jack(R) is used as an example tool.
Author
Anthropometry; Cockpits; Optimization; Computer Aided Design

19990032484 GEC-Marconi Research Centre, Great Baddow, United Kingdom
HUMAN RELIABILITY ASSESSMENT TOOLS: PHRASE 2
Buck, Brian, GEC-Marconi Research Centre, UK; Burrett, Gretchen, GEC-Marconi Research Centre, UK; A Designer's Guide to Human Performance Modelling; December 1998, A4-1 - A4-5; In English; See also 19990032479; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Human Reliability Assessment (HRA) tools seek to quantify the likelihood of human error given that error mechanisms have been identified. They form an integral part of a larger process of Human Reliability Assessment. HRA has traditionally been used primarily in the process control industries, but some methods are appropriate to military applications. Its use requires skilled practitioners. HRA is not a substitute for detailed human factors assessment when the objective is to maximise human performance. However, it will assist in directing design and evaluation effort where the human contribution is most critical. This paper outlines how HRA tools can be applied to cockpit design and describes the HRA process. PHRASE 2 is used as an example tool.
Author
Human Factors Engineering; Pilot Error; Pilot Performance; Reliability; Assessments

19990032485 Honeywell Technology Center, Minneapolis, MN United States
CASE STUDY INVOLVING FAIT
Riley, Victor, Honeywell Technology Center, USA; A Designer's Guide to Human Performance Modelling; December 1998, A5-1 - A5-14; In English; See also 19990032479; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This document describes in detail the capabilities of Honeywell's Function Allocation Issues and Tradeoffs (FAIT) methodology, its assumptions and philosophy, methods of use, and types and utility of output. This case studies illustrates the process and applicability of FAIT in evaluating the potential human factors issues inherent in a proposed piece of aircraft automation: a new implementation of data link technology.
Author
Human Factors Engineering; Systems Engineering; Complex Systems; Data Links; Man Machine Systems; Air Traffic Control; Decision Support Systems

19990032487 Honeywell Technology Center, Minneapolis, MN United States
CASE STUDIES INVOLVING W/INDEX
Miller, Christopher A., Honeywell Technology Center, USA; A Designer's Guide to Human Performance Modelling; December 1998, A7-1 - A7-9; In English; See also 19990032479
Contract(s)/Grant(s): DAAJ02-92-R-0037; DAAA15-89-C-0021; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

This document describes in detail the capabilities of Honeywell's Workload Index (W/Index) too], its assumptions and philosophy, methods of use, and types and utility of output. Two case studies are provided to illustrate the process and applicability of workload prediction using W/Index: (1) an example evaluating crew station layout and functionality in an advanced attack/scout helicopter domain, and (2) an example evaluating alternate methods of crew reduction through added automation in an existing tank.
Author
Workloads (Psychophysiology); Computerized Simulation; Crew Workstations; Man Environment Interactions

19990032488 Micro Analysis and Design, Boulder, CO United States
WORKED EXAMPLE OF THE USE OF WINCREW IN THE EVALUATION OF OVERALL SYSTEM PERFORMANCE
Laughery, R., Jr., Micro Analysis and Design, USA; A Designer's Guide to Human Performance Modelling; December 1998, A8-1 - A8-21; In English; See also 19990032479; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

WinCrew is a tool for constructing system performance models for existing or conceptual systems when a central issue is whether the humans and machine will be able to handle the workload. WinCrew can be used to predict operator workload for a crew given a design concept. WinCrew also has the ability to model and predict the effects of that workload on crew and system performance. What separates WinCrew from other workload models is this direct link between task-induced workload and the effect on system performance. With WinCrew, you can predict how the human will dynamically alter his behaviour when he or she encounters high workload situations. WinCrew can simulate the following as a function of high workload: dynamic allocation of tasks between humans, machines; dropping tasks based on task priority; and task time and accuracy degradation.
Derived from text
Human Performance; Performance Prediction; Workloads (Psychophysiology); Man Machine Systems; Dynamic Models; Systems Engineering; System Effectiveness

19990032489 NASA Ames Research Center, Moffett Field, CA United States
MAN-MACHINE INTEGRATED DESIGN AND ANALYSIS SYSTEM (MIDAS): FUNCTIONAL OVERVIEW
Corker, Kevin, NASA Ames Research Center, USA; Neukom, Christian, NASA Ames Research Center, USA; A Designer's Guide to Human Performance Modelling; December 1998, A9-1 - A9-15; In English; See also 19990032479; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Included in the series of screen print-outs illustrates the structure and function of the Man-Machine Integrated Design and Analysis System (MIDAS). Views into the use of the system and editors are featured. The use-case in this set of graphs includes the development of a simulation scenario.
Derived from text
Man Machine Systems; Computerized Simulation; Systems Engineering; Systems Simulation; Systems Integration; Systems Analysis

19990032490 Advisory Group for Aerospace Research and Development, Human Performance Modelling Working Group, Neuilly-Sur-Seine, France
APPENDIX B: WEIGHTINGS AND RATINGS MATRICES
A Designer's Guide to Human Performance Modelling; December 1998, B1 - B-12; In English; See also 19990032479; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This appendix contains the matrices used to define the weightings and ratings of the models implemented in the HOMER Expert System. It also contains examples of two completed tables. B1 contains models contained in HOMER Version I, B2 contains HOMER assessment of model capabilities - MIDAS, and B3 contains HOMER assessment of model capabilities - ORACLE.
Derived from text
Expert Systems; Assessments; Evaluation

60
COMPUTER OPERATIONS AND HARDWARE

19960008186 Advisory Group for Aerospace Research and Development, Sensor and Propagation Panel, Neuilly-Sur-Seine, France
OPTICAL PROCESSING AND COMPUTING *LE TRAITEMENT OPTIQUE DE DONNEES ET L'INFORMATIQUE*
Sep 1, 1995; 147p; In English; In French; AGARD SPP Lecture Series on Optical Processing and Computing, 19-20 Oct. 1995, Paris, Rome, Ankara, France, Italy, Turkey; See also 19960008187 through 19960008191; Submitted for publication in AGARD-LS-199
Report No.(s): AGARD-LS-199; NIPS-95-06213; ISBN 92-836-0018-5; Avail: CASI; A07, Hardcopy; A02, Microfiche

Optical computing possesses some inherent advantages over electronic computing, in particular for massive data storage and parallel and neural processing. The main aim of this lecture is to show how recent advances in lightwave technology make the time ripe to consider exploiting the potential of optical computing for data processing applications. An overview is presented of the basic concepts and inherent advantages of using optics for data processing and computing applications. The use of optics for interconnecting electronic and optoelectronic processors and the use of optoelectronic techniques to enhance the performance of various computing devices and systems are discussed. An overview is given of the emerging field of artificial neural networks as a signal processing paradigm and their optical implementations. Recent developments in optoelectronic data communication are described.
Author (revised)
Electro-Optics; Optical Computers; Optical Data Processing; Optical Memory (Data Storage); Optoelectronic Devices; Photonics; Signal Processing

19960008188 Centre National de la Recherche Scientifique, Inst. d'optique., Orsay, France
IMPACT OF OPTICS ON COMPUTING SYSTEMS: FROM OPTICAL INTERCONNECTS TO DEDICATED OPTOELECTRONIC MACHINES
Chavel, Pierre, Centre National de la Recherche Scientifique, France; AGARD, Optical Processing and Computing; Sep 1, 1995, 12 p; In English; See also 19960008186; Avail: CASI; A03, Hardcopy; A02, Microfiche

In telecommunication systems, optics is now a pervasive technology. Its advantage of high communication throughput is relevant also to computing systems. However, eliciting the full benefit of optics will first require the development of techniques for integrating a large number of optical channels in a system and to understand the implication on computer architecture. We start with a review of the physical bases that justify the use of optics for implementing interconnect networks and, more generally, for designing future computing (as well as digital signal processing) systems. This analysis determines

the logical sequences of the following sections: optoelectronic technologies that are already available at present allow the demonstration of a number of functions and extrapolation to many others. One can envisage an evolutionary path and a revolutionary path. In the first case, optical functions are added to architectures that are otherwise determined by standard microelectronics concept; under this heading, we shall examine optical interconnect networks for computing systems with a relatively high degree of parallelism. The second path implies completely revisiting architectural concepts down to circuit design. Based on the concepts of 'smart pixels' and cellular automata, it suggests a number of ideas for dedicated processors applicable in particular to vision machines with massive parallelism.
Author (revised)
Architecture (Computers); Optical Computers; Optical Coupling; Optical Data Processing; Optoelectronic Devices

19960008189 California Univ., Dept. of Electrical and Computer Engineering., San Diego, CA, United States
PARALLEL ACCESSED OPTICAL STORAGE
Esener, Sadik, California Univ., USA; AGARD, Optical Processing and Computing; Sep 1, 1995, 36 p; In English; See also 19960008186; Avail: CASI; A03, Hardcopy; A02, Microfiche

The computational power of current high-performance computers is increasingly limited by data storage and retrieval rates rather than the processing power of the central processing units. No single existing memory technology can combine the required fast access and large data capacity. Instead, a hierarchy of serial access memory devices has provided a performance continuum which allows a balanced system design. Conventional memory technology can only marginally support the needs of high performance computers in terms of required capacity, data rate, access times, and cost. Significant gaps in secondary and tertiary storage have emerged which make storage hierarchy design increasingly difficult. This paper reviews a radically different approach to data storage using the parallelism and three dimensionality of optical storage. Three-D optical storage has the potential to significantly alter the present hierarchy and fill the pressing need for high performance secondary and tertiary storage systems.
Author
Computer Storage Devices; Data Storage; Memory (Computers); Optical Computers; Optical Data Storage Materials; Optical Memory (Data Storage)

19960009081 Advisory Group for Aerospace Research and Development, Fluid Dynamics Panel, Neuilly-Sur-Seine, France
PARALLEL COMPUTING IN CFD *L AERODYNAMIQUE NUMERIQUE ET LE CALCUL EN PARALLELE*
Oct 1, 1995; 346p; In English; See also 19960009082 through 19960009089; Prepared in cooperation with Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium)
Report No.(s): AGARD-R-807; NIPS-95-06204; ISBN 92-836-1025-3; Avail: CASI; A15, Hardcopy; A03, Microfiche

Lecture notes for the AGARD Fluid Dynamics Panel (FDP) Special Course on 'Parallel Computing in CFD' have been assembled in this report. The aim and scope of this Course was to present and discuss the latest advances and future trends in the application of parallel computing to solve computationally intensive problems in computational fluid dynamics (CFD). Topics in this lecture series focus on the increasingly sophisticated types of architectures now available, and how to exploit these architectures by appropriate algorithms for the simulation of fluid flow. Some of the subjects discussed are: parallel algorithms for computing compressible and incompressible flow; domain decomposition algorithms and partitioning techniques; and parallel algorithms for solving linear systems arising from the discretized partial differential equations.
Author (revised)
Algorithms; Computational Fluid Dynamics; Parallel Processing (Computers)

19970029370 Societe d'Applications Generales d'Electricite et de Mecanique, Cergy-Pontoise, France
SYSTEM OF MISSION REGISTRATION AND RESTITUTION *SYSTEME D'ENREGISTREMENT ET RESTITUTION DE MISSION*
Parisot, F. X., Societe d'Applications Generales d'Electricite et de Mecanique, France; Jul. 1997; 8p; In French; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

SAGEM S.A. company presents an architecture for embedded recording of multiple video signals and digital data on an single tape, and their ground restitution. The System Emports Interface Box (BISE) is an hardened equipment, mounted on ACE/Rafale aircraft. It manages all interfaces between aircraft and stores, following the MIL-STD-1760 standard: digital buses, video signals and synchronisation/ blanking signals. One of its function is to realize the time multiplexing and data marking of several video signals, for mission recording on magnetic tape. A ground PC-based equipment has been developed in parallel for the restitution of these video signals and data. Some data are used to synchronize the visualization of the video source chosen by the operator. The considered evolutions of this architecture are discussed, with digital video recording and restitution.
Author
Ground Support Equipment; Digital Data; Digital Television; Magnetic Tapes

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COMPUTER PROGRAMMING AND SOFTWARE

19950026721 Lucas Electronics, Birmingham, United Kingdom
THE APPLICATION OF ADA AND FORMAL METHODS TO A SAFETY CRITICAL ENGINE CONTROL SYSTEM
Dolman, W. C., Lucas Electronics, UK; Ashdown, A. M., Lucas Electronics, UK; Mccallion, K. J., Ministry of Defence, UK; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 13 p; In English; See also 19950026705; Copyright; Avail: CASI; A03, Hardcopy; A02, Microfiche

The procurement executive of the UK Ministry of Defense, MoD (PE) identified Ada as the single preferred high level language for the implementation of defense real time operational systems from 1 July 1987. This meant that projects selecting an implementation language after that time must select Ada, unless there are sound and documented reasons for using an alternative. MoD (PE) therefore decided to invite proposals for the High Order Language Demonstrator (HOLD) to examine the applicability of Ada to an aero gas turbine full authority digital engine control (FADEC), and awarded the contract to Lucas Electronics, Birmingham. This paper describes the work carried out by Lucas Electronics on this contract.
Derived from text
Ada (Programming Language); Aircraft Engines; Engine Control; Flight Safety; Gas Turbine Engines; Language Programming; Real Time Operation

19960016911 Compagnie International de Service en Informatique, Rungis, France
C3I: WAR GAME AND TECHNICAL-OPERATIONAL SIMULATION *C3I: SIMULATION TECHNICO-OPERATIONNELLE ET WARGAME*
Canazzi, Dominique, Compagnie International de Service en Informatique, France; Mollard, Regis, Paris V Univ., France; Oct. 1995; 6p; In French; See also 19960016897; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This article deals with the problem of making an early decision on the type of simulation to be used and eventual costs of the simulation program. The person in charge of the program wants to make conceptual decisions as late as possible, and the author says that simulation can greatly help in making these decisions. Three kinds of simulation are dealt with: technical-operational simulation at the gross level involving simple models and no human intervention; war game level simulation with human involvement and more complex models; and finally the most detailed simulator level, which includes human intervention and possible environmental factors. The author then discusses the role of the human operator in the various war game scenarios.
Transl. by Schreiber
War Games; Computerized Simulation; Environment Simulators; Training Simulators; Operations Research; Decision Making

19970000601 Sogitec Electronique, Electronique Div., Suresnes, France
APOGEE: A BREAKTHROUGH IN SYNTHETIC IMAGE GENERATION
Chauvin, Jean-Claude, Sogitec Electronique, France; Apr. 1996; 8p; In English; See also 19970000594; Copyright Waived; Avail: CASI;

A02, Hardcopy; A04, Microfiche

Though polygon and pixel capacity remain significant parameters of real time image generators, the visual aspect and the content's quality of the images take more and more importance with their utilization in NOE flight of helicopters, or combined arms simulation and interoperability context. In this field, APOGEE represents a breakthrough in real time image quality and complex scene content restitution. An improved management of the database guarantees the best restitution of the scene content accounting for the specific polygon and pixel capacity of one system. AZtec, the new algorithm developed by Sogitec for hidden part elimination and antialiasing, allows for processing of opaque, transparent, or lighting polygon participation, in any number and in any order. A nice rendering of complex scenes, regarding the lighting and shading aspect, is obtained without the sorting constraints encountered in similar systems, to process transparent faces at the end of the computation cycle. On the whole, the optimization and the integration of all stages of the APOGEE image computer, provide the best figures on all image generation criteria, and offer modularity in terms of performance and image definition.

Author

Image Resolution; Illuminating; Helicopters; Image Analysis; Image Converters; Image Enhancement; Imaging Techniques

19970000602 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Flight Mechanics, Brunswick, Germany

THE RTSS IMAGE GENERATION SYSTEM

Alvermann, K., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Graeber, S., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Mager, J. W. L. J., Physics and Electronics Lab. TNO, Netherlands; Smit, M. H., Physics and Electronics Lab. TNO, Netherlands; Apr. 1996; 4p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Main market demands for the visual system of a simulator are photo-realism and low latency time. RTSS, a general purpose image generation module developed within the European ESPRIT project HAMLET, can meet these demands through the use of High Performance Computing technology. This technology provides the needed communication and computing power. Moreover, by using parallel processing, the whole system is scalable, i.e., the same software and hardware design can be used for small, cheap systems, as well as for high-end view simulations. This allows an easy adaptation to the user's needs. RTSS also includes an object and scenario editor implemented on a work station, as well as filters to other object data standards. This paper will give an introduction to the soft- and hardware design of RTSS. It will then present the features of the system as well as the interfaces the filters to import external model data and the interfaces to the simulation system itself.

Author

Computer Programs; Data Systems; Computers

19970000605 NASA Ames Research Center, Moffett Field, CA United States

SIMULATION OF ROTOR BLADE ELEMENT TURBULENCE

McFarland, R. E., NASA Ames Research Center, USA; Duisenberg, Ken, Syscon Corp., USA; Apr. 1996; 12p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A turbulence model has been developed for blade-element helicopter simulation. This model, called Simulation of Rotor Blade Element Turbulence (SORBET), uses an innovative temporal and geometrical distribution algorithm that preserves the statistical characteristics of the turbulence spectra over the rotor disc, while providing velocity components in real time to each of five blade-element stations along each of four blades. An initial investigation of SORBET has been performed using a piloted, motion-based simulation of the Sikorsky UH60A Black Hawk. Although only the vertical component of stochastic turbulence was used in this investigation, vertical turbulence components induce vehicle responses in all translational and rotational degrees of freedom of the helicopter. The single-degree-of-freedom configuration of SORBET was compared to a conventional full 6-degrees-of-freedom baseline configuration, where translational velocity inputs are superimposed at the vehicle center of gravity, and rotational velocity inputs are created from filters that approximate the immersion rate into the turbulent field. For high-speed flight the vehicle responses were satisfactory for both models. Test pilots could not distinguish differences between the baseline configuration and SORBET. In low-speed flight the baseline configuration received criticism for its high frequency content, whereas the SORBET model elicited favorable pilot opinion. For this helicopter, which has fully articulated blades, results from SORBET show that vehicle responses to turbulent blade-station disturbances are severely attenuated. This is corroborated by in-flight observation of the rotor tip path plane as compared to vehicle responses.

Author

Rotors; Blades; Motion Simulation; Helicopters; Degrees of Freedom; Center of Gravity; High Frequencies

19970000606 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik, Brunswick, Germany

C-160 GROUND HANDLING MODEL UPDATE USING TAXI TEST DATA

Fischenberg, D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Moennich, W., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Apr. 1996; 8p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The need for representative ground handling modelling for flight simulators according to modern approval standards is generally strong. A main problem is to find an adequate level of model accuracy for the complex physics of ground related maneuvers. In this paper some examples of the development process of a C-160 ground handling model are presented. The original analytically derived model is updated and validated with taxi test data using system identification methods. Not only the identification of model parameters is discussed, but it is also demonstrated how to derive equivalent submodels in order to reduce the complexity of the data bases without hardly any loss of simulation fidelity.

Author

C-160 Aircraft; Ground Handling; Parameter Identification

19970000607 Sogitec Electronique, Electronique Div., Suresnes, France

TACTICAL ENVIRONMENT SERVERS

Heran, Francois D., Sogitec Electronique, France; Apr. 1996; 4p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

Mission training or evaluation on a manned military simulator requires the presence of friend and foe forces. These forces, either computer generated or man-controlled, must react in an intelligent manner, in real time. Due to restrictions in software tools and computing power (or manpower in the case of dedicated manned stations), as well as emphasis put on procedural and skill training more than on mission training, many existing simulators feature little or no tactical environment. This paper presents a concept, the tactical environment server, which has been developed to populate the battle space of real time combat simulators with various computer generated friends and foes. In the first part, tactical environment requirements for air combat and land battle simulators are discussed. Coherence between the server and its clients, one of the most problematic technical issues, is analysed. A second part addresses the algorithmic and technological trade-offs one has to consider to implement a real-time tactical environment server. The connection of the server to the client simulator(s), via a network using the DIS protocol or via other solutions, is also discussed. Implementation of a tactical environment servers for a Mirage 2000 and a combat helicopter simulator are presented and conclusions are drawn.

Author

Protocol (Computers); Training Evaluation; Real Time Operation; Simulators; Helicopters; Combat

19970006909 Vrije Univ., Dept. of Electronics, Brussels, Belgium

A GENERIC IMAGE PROCESSING TOOL: TOP DOWN BAYESIAN IMAGE ANALYSIS

Dewitte, S., Vrije Univ., Belgium; Mangen, J. M., Royal Military Academy, Belgium; Cornelis, J., Vrije Univ., Belgium; Crommelynck, D., Institut Royal Meteorologique de Belgique, Belgium; Remote Sensing: A Valuable Source of Information; Oct. 1996; 12p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this paper we present the top down Bayesian analysis method. This method combines the multi-resolution aspects of the wavelet transform and the general applicability of image analysis in windows.

This generic top down method uses a general purpose image analysis algorithm which starts by analyzing a small amount of global data and refines these analysis results to a large amount of local information. As a refinement method, the theory of Bayes is used. We defined the top down Bayesian image analysis method mathematically in a general way, i.e., without specifying any specific analysis. This stresses the generic nature of the method. to demonstrate this unique method, we worked out its practical application by processing METEOSAT images in three different problems: smoothing interpolation; non-smoothing interpolation; and motion estimation.
Derived from text
Algorithms; Bayes Theorem; Wavelet Analysis; Image Processing; Satellite-Borne Radar

19970006910 Alcatel Espace, Nanterre, France
CLOSED FORM EXPRESSIONS OF ALGORITHMIC PERFORMANCE AND COMPLEXITY IN SIGNAL PROCESSING
Marguinaud, Andre, Alcatel Espace, France; Bertrand, Pierre, Alcatel Espace, France; Remote Sensing: A Valuable Source of Information; Oct. 1996; 16p; In English; See also 19970006887; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In spite of the price deflation of computing power and available simulation tools, closed-form bounds are necessary for system designers to check overall simulation results and to decrease costs. The mathematical concepts used to optimize the algorithms and their associated bounds are: analytic signal representation, the principle of Maximum Likelihood, Neaman Pearson formulation of requirements, Chernoff bounding, quantification optimization at each stage of the processing, weighted least squares, Lagrange multipliers, statistical generating functions, etc. The application of the above methods by means of analytical expressions of performance and graphics covers the following items encountered essentially in transmission: Non-linearity impact on system assessment, MFSK and MPSK modulation, soft decoding of convolutional codes, and combinations of inner and outer codes.
Author
Algorithms; Computerized Simulation; Cost Reduction; Signal Processing

19970010671 FAIR Information Services, Amsterdam, Netherlands
A MULTIDISCIPLINARY APPROACH IN COMPUTER AIDED ENGINEERING
Laan, D. J., FAIR Information Services, Netherlands; Oct. 1996; 10p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Computer Aided Engineering (CAE) has a long history within Fokker. Already in 1955, the FERTA-computer (Fokkers Eerste Rekenapparaat Type Arra) was used for aeroelastic analysis of the F27. Many disciplines automated their design methods in the sixties and seventies. The resulting islands of automation started to be recognized as a problem only afterwards. Fokker Aircraft come to a point where significant progress could only be achieved by integrating the various disciplines and their CAE-models. These models should be applied in support of a properly design process. Therefore, the CAE-project was started in 1994. During this project a transition was made from 'each specialist building his own CAE-model' towards teamwork in building multidisciplinary CAE-models. This will be illustrated by a number of examples from such areas as weight and balance, flight dynamics and structural design and optimization. Finally, a view on future developments is presented, building on the historical perspective of CAE developments at Fokker Aircraft.
Author
Computer Aided Design; Multidisciplinary Design Optimization; Fokker Aircraft; Aircraft Design

19970029366 Bogazici Univ., Dept. of Computer Engineering, Istanbul, Turkey
A SURVEY OF ADVANCED INFORMATION PROCESSING (AIP) TECHNOLOGY AREAS FOR CREW ASSISTANT SYSTEM DEVELOPMENT
Kuru, S., Bogazici Univ., Turkey; Akin, H. L., Bogazici Univ., Turkey; Jul. 1997; 12p; In English; See also 19970029347
Contract(s)/Grant(s): Proj. 94A0108; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In this survey, carried out within the framework of EUCLID RTP 6.5 CREW ASSISTANT project, the following, Advanced information Processing (AIP) technology areas were surveyed: Software Engineering, Knowledge-Based Systems, Distributed Artificial Intelligence. Learning Systems, Planning, Model-Based Reasoning, Case-Based Reasoning, and Object-Oriented Databases. The survey evaluated the AIP technology areas with respect to the a predetermined set of criteria. The following criteria were used: Functionality Reliability, Performance, Modularity, Integration with other technologies, Engineering methodology, Maturity and next generation, and Availability within consortium. The main findings are: AIP technologies have a high degree of applicability in the A in general. The current state of the art in AIP technologies is at a mature level to offer acceptable solutions for the Crew Assistant development. It can be said that basically all of the AIP technologies investigated may be employed in some way in the CA development.
Author
Object-Oriented Programming; Systems Engineering; Software Engineering; Modularity; Information Systems; Expert Systems; Computer Programming; Artificial Intelligence

19970029377 Sverdrup Technology, Inc., Eglin AFB, FL United States
SELECTING A SOFTWARE DEVELOPER IN A SPECIFICATION FREE ACQUISITION ENVIRONMENT
Henne, Marlow, Sverdrup Technology, Inc., USA; Kandel, Abraham, University of South Florida, USA; Jul. 1997; 14p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper discusses a method to help in the selection of a software developer by performing in-plant capability reviews. The present trend not to use government standards, necessities the careful review of a contractor's capability and present development process.
Author
Computer Programs; Report Generators; Programmed Instruction

19970030248 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
ADVANCES IN SOFT-COMPUTING TECHNOLOGIES AND APPLICATION IN MISSION SYSTEMS *LES AVANCEES DES TECHNOLOGIES DU CALCUL SYMBOLIQUE ET LES APPLICATIONS AUX SYSTEMES NUMERIQUES DE GESTION DE LA MISSION*
Advances in Soft-Computing Technologies and Application in Mission Systems; Sep. 1997; 112p; In English, 17-18 Sep. 1997, North York, Amsterdam, Madrid, Ankara, Canada, Netherlands, Spain, Turkey; See also 19970030249 through 19970030255
Report No.(s): AGARD-LS-210; ISBN 92-836-1061-X; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

Contains the papers presented at a Lecture Series on 'Soft Computing' technologies. Soft computing addresses the pervasive imprecision of the real world by consideration of the tolerances for imprecision, uncertainty and partial truth to achieve tractable, robust and low-cost solutions for complex problems. Topics covered include soft computing for computation and machine intelligence, neural networks, fuzzy logic, inference and fuzzy control, hybrid architectures for intelligent and learning inference systems, and applications to target tracking and acquisition and the reconfiguration of damaged aircraft. The Lecture Series was sponsored by the Mission Systems Panel of NATO's Advisory Group for Aerospace Research and Development (AGARD).
Author
Artificial Intelligence; Software Engineering; Precision; Mathematical Models; Fuzzy Sets; Neural Nets; Algorithms

19970030249 Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen, Germany
TECHNIQUES FOR COMPUTATIONAL AND MACHINE INTELLIGENCE SOFT COMPUTING
Krogmann, U., Bodenseewerk Geraetetechnik G.m.b.H., Germany; Advances in Soft-Computing Technologies and Application in Mission Systems; Sep. 1997; 14p; In English; See also 19970030248; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

There is a paradigmatic complementary shift from symbolic AI/KB techniques to so called Soft Computing technologies. The new paradigm is based on modeling the unconscious, cognitive and reflexive function of the biological brain. In contrast to the conventional Hard Computing, Soft Computing addresses the pervasive impreci-

sion of the real world. This is accomplished by consideration of the tolerances for imprecision, uncertainty and partial truth to achieve tractable, robust and low cost solutions for complex problems. The objective of this paper is to introduce Soft Computing and to briefly familiarize the reader with important Soft Computing techniques. This is accomplished by first of all defining what is meant by computational and artificial intelligence and why as well as for which functions computational intelligence is needed. Based on brainlike structures the most important techniques of Soft Computing such as fuzzy logic, artificial neural networks and genetic algorithms are briefly described. The approaches treated provide the basis for adaptive, learning control, advanced automation and artificially intelligent machines.
Author
Artificial Intelligence; Genetic Algorithms; Reflectance; Computation; Unconsciousness; Cognitive Psychology

19980016584 Smiths Industries Aerospace and Defence Systems Ltd., Cheltenham, United Kingdom
MISSION SOFTWARE - THE NEXT 25 YEARS
Mayoh, Howard, Smiths Industries Aerospace and Defence Systems Ltd., UK; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 6p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The growth in computing technology over the last 25 years has been truly dramatic. The techniques used to develop the software have also seen significant changes. The growth in avionics software has been no less dramatic. This paper considers the changes that have occurred, and that will continue to take place in the future, in terms of three generations of avionic computing. The First Generation covers the early application of computing to mission system applications. These mission applications were distributed over few computing centres, with very little communication between them. The Second Generation of avionics computing is characterized by a major growth in the size and complexity of the software applications. The changes we can expect over the next generation, the Third Generation, of avionic computing will be as great as those between the first and the second. The most significant change will probably be in the avionic computing architecture, in that Integrated Modular Avionics (IMA) will be at the core of the avionic computing infrastructure. The need to reduce pilot workload and increase systems performance will demand an increase in the scale and complexity of mission management applications. to achieve the growth that will be required to support these new applications a significant increase in productivity will be required. The need to develop highly integrated applications across organizational boundaries will mean an increasing emphasis on integrated teams. A combination of IMA architecture, with the growth in size and complexity of the mission systems applications, will introduce a number of software management challenges.
Author
Avionics; Computer Programs; Aircraft Instruments; Systems Engineering; Electronic Modules; Architecture (Computers)

19980033523 McDonnell-Douglas Corp., Saint Louis, MO United States
VIRTUAL PRODUCT DEFINITION: THE KEY TO AFFORDABLE AND SUPPORTABLE PRODUCTS
Coyle, John M., McDonnell-Douglas Corp., USA; Paul, Don, Wright Lab., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 14p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Virtual product definition (VPD) is an emerging process which capitalizes on recent advances in computer hardware and software to enable a Paradyne shift in the way products are developed. Engineering, tooling, manufacturing and product support data that fully define the product is created and managed in a synthetic environment. All product definition geometry developed in the VPD process is defined as three dimensional solid digital models. This data is stored in an electronic medium with a common geometry database providing the primary linkage between the product design and a newly developed set of integrated design, analysis, manufacturing and supportability tools. The geometry related information that describes the product may be viewed and interacted with in a synthetic environment in the same way physical mockups were used in previous design processes. This geometric representation forms the most visible part of a Virtual Prototype.
Derived from text
Computer Programs; Software Engineering; Design Analysis; Product Development; Data Bases

19980202235 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France
VIRTUAL MANUFACTURING *LA FABRICATION VIRTUELLE*
Virtual Manufacturing; May 1998; 154p; In English; In French; AGARD Structures and Materials Panel, 13-14 Oct. 1997, Aalborg, Denmark; See also 19980202236 through 19980202248; Original contains color illustrations
Report No.(s): AGARD-R-821; AD-A346507; ISBN 92-836-0053-3; Copyright Waived; Avail: CASI; A08, Hardcopy; A02, Microfiche

Virtual Manufacturing (VM)is an integrated, synthetic manufacturing environment exercised to enhance all levels of decision and control. This process uses product, process and resource models to evaluate the producibility and affordability of new product concepts prior to commitment to the final product design. Design processes are captured in a single geometric database and integrated with the planned manufacturing processes resulting in a simulation of the manufacturing environment. The critical questions of manufacturing cycle time, people resource requirements and physical resource requirements for various scenarios are quantified by simulation. Thus, Virtual Manufacturing is a tool to achieve more affordable aircraft designs, reduced cycle times and improved quality.
Author
Virtual Reality; Manufacturing; Computer Aided Manufacturing; Computer Aided Design; Production Planning; Concurrent Engineering

19980202236 Short Bros. Public Ltd. Co., Engineering Centre, Belfast, United Kingdom
USE OF VIRTUAL PROTOTYPING IN DESIGN AND MANUFACTURING
Kingsbury, Alan, Short Bros. Public Ltd. Co., UK; Virtual Manufacturing; May 1998; 12p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

In 1989, Shorts first looked at the potential of replacing physical wooden mock-ups with electronic solid model assemblies. They took existing drawings of the F100 wing and translated these into a solid mock-up. Although these early solid modellers were not user friendly, the resulting demonstrator was impressive and proved that large assemblies could be produced. This gave Shorts the confidence to embark on a small production contract - Trent Nacelle. This had 10 designers working concurrently generating structures, hydraulic and electrical systems all as solid models. Initially there was concern because the project planners who traditionally measure drawing output were getting very little drawings released during the first half of the program as the solid models and assemblies were being created. However, the drawing output increased dramatically near the end because of the fast production of assembly drawings giving a resulting overall reduction in leadtime of 20%. This result set the scene for the technology strategy on the Lear 45 when the decision was made to solid model the complete aircraft including all structures, hydraulic and electrical systems.
Author
Manufacturing; Design Analysis; Prototypes; Concurrent Engineering; Systems Integration; Lear Jet Aircraft; Aircraft Models

19980202237 Dassault Aviation, Saint-Cloud, France
A VIRTUAL RAFALE: COMPLETELY DIGITAL APPROACH FOR PRODUCT AND PROCESS
Rouchon, C., Dassault Aviation, France; May 1998; 6p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

To survive in strong present competition, Dassault Aviation has to ensure a constant update of its organization, management methods and information system. This permanent research has to produce a right compromise between cost, cycle and performances, both for civil and military aircraft. The Digital Mock-Up (DMU) provides support for Concurrent Engineering (CE) methodologies and contributes directly to customer satisfaction. In the first part, we will introduce the Dassault's use of CE methodologies as a systematic approach to inte-

grated development of a product with the manufacturing processes and customer support. We will emphasize the importance of Teamwork-based decisions, co-specifications, cross-discipline cooperation, efficient communication, change management, simulations, etc. The second part will be dedicated to CAD/CAM techniques and their extension: Virtual Reality (VR). We will not mention all the activities related to flight simulators.
Author
Management Methods; Costs; Information Systems; Concurrent Engineering; Computer Aided Manufacturing; Computer Aided Design; Virtual Reality

19980202238 Daimler-Benz Aerospace A.G., Optical Measurement Methodologies, Ulm, Germany
VIRTUAL MANUFACTURING: FROM OPTICAL MEASUREMENT TO RAPID PROTOTYPING
Juenemann, G., Daimler-Benz Aerospace A.G., Germany; May 1998; 10p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

While a CAD model provides the starting point in conventional "engineering", the process is turned upside down in "reverse engineering", for an existing physical part is the starting point. We have developed an innovative reverse engineering tool providing an efficient link between the real world and the virtual world. Surface-like measuring technology provides "express access" to the world of computer data. Innovative triangulation procedures enable complicated CAD modelling to be circumvented, thus providing a direct transition to production.
Author
Manufacturing; Optical Measurement; Prototypes; Reverse Engineering; Virtual Reality

19980202239 Aerospatiale, Dept. DCR/IK, Suresnes, France
AEROSPACE APPROACH FOR VIRTUAL MANUFACTURING *APPROCHE AEROSPATIALE POUR LA FABRICATION VIRTUELLE*
Dureigne, M., Aerospatiale, France; May 1998; 6p; In French; See also 19980202235; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The paper analyzes, in the first step, virtual manufacturing deployment within Aerospatiale with the development of information technology tools. It points out the importance of man and the diversity of solutions. This deployment is clearly linked to the main characteristics of Aerospatiale: high technology, human potential stable, skilled and open to innovation, all products developed in a multi-language and cultural partnership. In the second step, the deployment is analyzed through a system methodology to derive the main drivers of the deployment. In the last step, the paper presents the research work preparing the next state of deployment. This state will put emphasis on refined product models, distributed virtual manufacturing and semantic based language to improve both people and machine data processing. But as usual, the next state will heavily rely on the ability of research work to lead to easy appropriation of new technologies by people and organizations.
Author
Manufacturing; Information Systems; Data Processing; Technologies; Virtual Reality; Architecture (Computers); Deployment; Computer Aided Design

19980202240 Wright Lab., Simulation Assessment Validation Environment Program, Wright-Patterson AFB, OH United States
SIMULATION ASSESSMENT VALIDATION ENVIRONMENT (SAVE) REDUCING COST AND RISK THROUGH VIRTUAL MANUFACTURING
Poindexter, James W., Wright Lab., USA; Cole, Paul E., Lockheed Aeronautical Systems Co., USA; May 1998; 10p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The 1994 Lean Aircraft Initiative industry forum, identified the application of Virtual Manufacturing (VM), in the form of integrated simulation technologies, as a key technology in reducing cost and increasing quality. The Joint Strike Fighter Program initiated the Simulation Assessment Validation Environment (SAVE) Program to integrate a set of VM tools and to validate the potential savings through a series of demonstrations. This paper describes the SAVE program and its potential for a $3 Billion (US) savings on the Joint Strike Fighter program.
Author
Virtual Reality; Manufacturing; Cost Reduction; Aircraft Industry; Systems Integration; Functional Design Specifications

19980202241 British Aerospace Airbus Ltd., Electronic Product Definition Project, Bristol, United Kingdom
IMPLEMENTATION OF AIRBUS CONCURRENT ENGINEERING
Landeg, Bob, British Aerospace Airbus Ltd., UK; Ash, Steve, British Aerospace Airbus Ltd., UK; May 1998; 10p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

In the 27 years since it was founded, Airbus Industrie has developed a portfolio of aircraft in the above 100 seat range which has captured over 35% of the global market. This has been achieved despite the the fact that, up to 1995, the Airbus partners used a variety of software systems. However, at the end of 1995, the four Airbus partners signed an historic contract, committing the partnership to buying at least 1500 seats of common CAD/CAM/CAE and enterprise data management software from a common supplier - Computervision. Airbus realized that its aggressive competitive goals could only be reached if all partners adopt common ways of working across Europe. to drive this change, it launched an Airbus Concurrent Engineering (ACE) project in 1996 to enable it to revolutionize the way it designs, builds and supports aircraft . This paper will describe the work in British Aerospace to produce a radical vision of world class people, processes, systems, teamworking and performance. It will illustrate how this vision was developed and shared by the Airbus partnership, resulting in a strategic plan to provide a revolutionary change in performance, enabling Airbus Industrie to proceed towards its goal of being a leading aircraft manufacturer in the world. It will show that ACE is "not just another IT programme" but a change programme delivering hardware, software, networks, processes, tools, methodologies, organization, training and support in a contract with Airbus aircraft programmes called a "version". The pivotal role that the ACE project plays was reinforced by the Airbus partners signing a memorandum of understanding with the intention to establish a single Airbus company by 1999.
Author
Concurrent Engineering; European Airbus; Computer Aided Design; Computer Aided Manufacturing; Project Management; Project Planning

19980202242 Boeing Co., Information, Space and Defense Systems, Seattle, WA United States
VIRTUAL MANUFACTURING TECHNOLOGY IMPLEMENTATION AT BOEING
Renton, W. J., Boeing Co., USA; Rudnick, F. C., Boeing Co., USA; Brown, R. G., Deneb Robotics, Inc., USA; May 1998; 8p; In English; See also 19980202235; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Virtual Manufacturing is an integrated set of tools and technologies which provide a highly accurate near real time 3D simulation environment to evaluate: new or exiting methods and processes; tool and fixture design/assembly sequences; facility layouts and material flow; ergonomic/human factors; and alternate production scenarios involving one or more products. Boeing is expanding its usage of these tools and technologies, as utilization in selected applications has demonstrated dramatic improvements in reducing cycle time and cost, while improving productivity and product quality. This paper will discuss our application of and experience with Virtual Manufacturing for an ever expanding breadth of applications. These include; simulating kinematic devices for Space Station; robotic painting; visualization of airplane assembly processes; and simulation of man/machine interactions, numerically controlled (N.C.) machining cells and composite fabrication processes. With the successes experienced to date, the authors will look into the next millennium, projecting further advancements in technology and its' projected usage in the aerospace industry.
Author
Virtual Reality; Manufacturing; Computerized Simulation; Human Factors Engineering; Fabrication; Cost Reduction; Technology Utilization

19980202243 Daimler-Benz Aerospace A.G., Munich, Germany
VIRTUAL MANUFACTURING FOR COMPOSITES
Berchtold, G., Daimler-Benz Aerospace A.G., Germany; May 1998; 12p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The geometry based aircraft design to manufacturing process is described, highlighting the extensive use of simulation activities along its phases to verify the geometry. It is shown that the manufacturing simulation has an exceptional role in minimizing or even avoiding global iteration loops. In addition, some wording is defined in the world of virtual manufacturing to be able to position the different software developments. Based on this information two examples are shown - the composite stiffener technology and the composite skin technology - both based on prepreg tape targeting for high performance aircraft structures. Due to the full usage of all necessary material-, manufacturing-, and machine data right from the beginning of the design it is demonstrated that a fully automatic NC-code generation can be achieved at the end of the engineer's design process producing verified manufacturable data without any additional human interaction based on the designed geometry. By means of this, time consuming iteration loops coming back from the manufacturing phases and creating local iteration loops to the structural analysis are avoided. Real examples of this "virtual manufacturing" process are indicating 10 to 50 times faster processes compared to existing methods. Finally, for both manufacturing technologies the integration with the corresponding optimization code is explained, outlining the important issues in this field.
Author
Structural Analysis; Aircraft Design; Aircraft Structures; Prepregs; Manufacturing; Virtual Reality; Computerized Simulation; Composite Materials; Optimization

19980202244 Katholieke Univ. te Leuven, Dept. of Mechanical Engineering, Belgium
AN OBJECT-ORIENTED TAXONOMY FOR PART AND PROCESS DESIGN
VanZeir, G., Katholieke Univ. te Leuven, Belgium; Kruth, J.-P., Katholieke Univ. te Leuven, Belgium; May 1998; 12p; In English; See also 19980202235; Sponsored in part by GOA and IUAP
Contract(s)/Grant(s): ESPRIT Proj. 6805; GOA Proj. 95-2; IUAP Proj. 50; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper describes an object-oriented data/knowledge model for interactive part and process design. This model is employed in a Computer Aided Process Planning (CAPP) kernel. Objects are used to represent the process planning information. Each data-object has attributes, a set of methods, a constructor, etc. The information contained in such objects can be supplied either by a software expert module or by the human expert, through an interface that is provided for each type of object. Consulted expert modules will take into account the information that was added by the human expert (or by earlier consulted expert modules). Moreover, the interface to human expert allows him/her to verify, accept or alter the information generated by an expert module, at any time. Objects with partial information (empty attributes, attributes that describe intervals or constraints or multiple discrete values, etc.) will be called virtual objects, while objects that are unambiguously determined by the information contained in their attributes will be called physical objects. The paper elaborates on the distinct knowledge sources and their relation with the data model. It explains, for each knowledge source, its representation and its instantiation. Further, the aspect virtual versus physical object is handled; i.e. how virtual objects evolve towards physical objects by providing them with necessary information.
Author
Object-Oriented Programming; Taxonomy; Design Analysis; Prototypes; Computer Aided Design; Virtual Reality; Production Planning

19980202245 Wright Lab., Manufacturing Directorate, Wright-Patterson AFB, OH United States
JOINT STRIKE FIGHTER MANUFACTURING DEMONSTRATION (JMD): INTEGRATING DESIGN AND COST FOR AN AFFORDABLE WEAPON SYSTEM
Herner, Alan E., Wright Lab., USA; Rowland, Jerold K., Hughes Aircraft Co., USA; May 1998; 12p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

In 1995, the Joint Strike Fighter (JSF) program office, through the USAF Wright Laboratory's Manufacturing Directorate, contracted with Hughes Aircraft Company to define and demonstrate a development methodology that incorporates lean practices and tools and integrates design and cost information. This methodology will be refined, demonstrated and shared with the JSF contractor community. The JMD program is a 40-month effort in two phases. The first phase developed the initial JMD lean methodology and demonstrated its application to a Transmit/ Receive microwave electronic modules used in active array radars. The second phase will refine the methodology and demonstrate it on a more complex subarray assembly. This paper describes the JMD program and presents its progress to date.
Author
Manufacturing; Design to Cost; Technology Transfer; Product Development; Weapon Systems; Electronic Modules

19980202246 Greenwich Univ., Centre for Numerical Modelling and Process Analysis, London, United Kingdom
MULTI-PHYSICS MODELLING: A VITAL COMPONENT OF VIRTUAL MANUFACTURING
Cross, M., Greenwich Univ., UK; Bailey, C., Greenwich Univ., UK; Pericleous, K., Greenwich Univ., UK; McManus, K., Greenwich Univ., UK; Bounds, S., Greenwich Univ., UK; Moran, G., Greenwich Univ., UK; Taylor, G., Greenwich Univ., UK; Wheeler, D., Greenwich Univ., UK; May 1998; 12p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

One of the core tasks of the virtual-manufacturing environment is to characterize the transformation of the state of material during each of the unit processes. This transformation in shape, material properties, etc. can only be reliably achieved through the use of models in a simulation context. Unfortunately, many manufacturing processes involve the material being treated in both the liquid and solid state, the transformation of which may be achieved by heat transfer and/or electromagnetic fields. The computational modeling of such processes, involving the interactions amongst various interacting phenomena, is a considerable challenge. However, it must be addressed effectively if Virtual Manufacturing Environments are to become a reality. This contribution focuses upon one attempt to develop such a multi-physics computational toolkit. The approach uses a single discretization procedure and provides for direct interaction amongst the component phenomena. The need to exploit parallel high performance hardware is addressed so that simulation elapsed times can be brought within the realism of practicality. Examples of multiphysics modelling in relation to shape casting, and solder joint formation reinforce the motivation for this work.
Author
Manufacturing; Heat Transfer; Computerized Simulation; Mechanical Properties; Virtual Reality; Parallel Processing (Computers)

19980202248 Prosolvia Clarus A.B., Gothenburg, Sweden
A RADICAL NEW WAY OF PRODUCT DEVELOPMENT: EXPLORING THE BENEFITS WITH VIRTUAL REALITY IN VIRTUAL CONCEPT
Nordlander, Sverker, Prosolvia Clarus A.B., Sweden; May 1998; 8p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

With the introduction of powerful Virtual Reality (VR) tools, changes to the product development process have started. However, the potential of these tools are today not fully explored since the changes to the process still is very limited. The technique behind VR and the possibilities that it offers is very promising. Due to increasing performance of computers, at a reasonable low price, it is now possible to implement and use VR for several new tasks that earlier were restricted due to the complexity of the system and cost of the solution. Using it in new areas also put additional requirements on the solutions such as the need for simpler user interfaces. In this paper, a new way of using VR technology in product development is described together with some of the benefits it gives. Some of the requirements on the

environment is also discussed and a new phrase "Virtual Concept" is introduced as well as a short description on the thoughts behind the model.
Author
Product Development; Virtual Reality; Computer Aided Manufacturing; Computer Aided Design; Models

19980202475 Colorado Univ., Dept. of Aerospace Engineering and Sciences, Boulder, CO United States
FAST STAGGERED ALGORITHMS FOR THE SOLUTION OF THREE-DIMENSIONAL NONLINEAR AEROELASTIC PROBLEMS
Farhat, Charbel, Colorado Univ., USA; Lesoinne, Michel, Colorado Univ., USA; Mar. 1998; 12p; In English; See also 19980202469
Contract(s)/Grant(s): F49620-97-1-0059; NAG2-827; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

We overview two sequential and parallel partitioned procedures that are popular in computational nonlinear aeroelasticity, and address their limitation in terms of accuracy and numerical stability. We propose two alternative serial and parallel staggered algorithms for the solution of coupled transient aeroelastic problems, and demonstrate their superior accuracy and computational efficiency with the flutter analysis of the AGARD Wing 445.6. We contrast our results with those computed by other investigators and validate them with experimental data.
Author
Flutter Analysis; Aeroelasticity; Numerical Stability; Parallel Processing (Computers); Staggering; Parsing Algorithms; Three Dimensional Models; Mathematical Models; Conservation Laws; Nonlinearity

19990007860 Johns Hopkins Univ., Applied Physics Lab., Laurel, MD United States
LAYERED FAULT TOLERANT ARCHITECTURE TO SUPPORT CONTEXT-SENSITIVE REASONING FOR LETHAL UNMANNED AERIAL VEHICLE APPLICATION
Rau, Jennifer, Johns Hopkins Univ., USA; Jul. 1998; 8p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper provides a description of communication utilities implemented to support fault tolerant features for a layered processor architecture. The defined software modules used existing message passing software based on TCP/IP, UDP protocols. The prototype software was tested to verify the routing, network diagnosis, and network recovery functions. Message traffic was monitored and after inducing a failure, the application was restarted without loss of state. The capability provided by these software modules can be readily applied with the definition of application specific messages and state variables. The layered processor architecture and associated communication utilities were developed to provide a basis for improved autonomous vehicle performance. It supports this goal by providing graceful degradation due to processor failures, optimization of onboard processing capability, subsystem communications, data collection and validation of subsystem data to support context-sensitive reasoning, elimination of single point failures in the processor and communications architecture, and isolation of high-level processing functions from payload integration specifics. A candidate software architecture for lethal UAV reasoning functions has been provided to establish the benefits of an integrated design approach. This software architecture supports all key reasoning functions including; sensor management, weapon management, vehicle control, fault handling, target identification, target localization, maneuver control and mission replanning. The indicated data flows in the figures provided, identify interaction between these functions and subsystems. The defined software architecture for lethal UAV application builds on the layered processor architecture's key features to enhance the vehicle's mission effectiveness and survivability.
Author
Architecture (Computers); Onboard Data Processing; Fault Tolerance; Computer Programs; Message Processing; Software Engineering; Systems Integration; Protocol (Computers)

19990014357 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
(CFD) COMPUTER DEPENDENT DEVELOPMENTS, PROSPECTS AND CHALLENGES
Aerospace 2020; Sep. 1997; Volume 3, 15-32; In English; See also 19990014353; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This chapter is intended to highlight prospects and challenges of some topics of Fluid Dynamics considered to be critical to technology advances which are discussed in Volumes I and II or in other chapters of Volume III. Therefore it is not an exhaustive discussion of all of the required research in Fluid Dynamics necessary for technical leadership in the 21st Century. In this regard, the reader may not agree with the inclusion of some topics and the omission of others. The content reflects the concensus reached within the AGARD Fluid Dynamics Panel on "critical" topics. Continued research in Fluid Dynamics will be necessary in order to realize the affordability goals that NATO is discussing for future systems. Whether the medium be water, air or real gases, fluid dynamics is the technical area that determines the external shape and controllability of the vehicle to satisfy the design mission requirements. Designing the vehicle correctly the first time has an enormous influence on the total design cycle. In addition, the accurate determination of vehicle performance, controllability, and loads through continued improvement in Computational, Experimental and Fundamental Fluid Dynamics, will allow design margins in other technical disciplines (i.e. Structures, etc.) to be reduced thereby providing the most economical integrated design.
Derived from text
Fluid Dynamics; Computer Techniques; Technology Assessment; Wind Tunnel Tests

19990014377 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
SEAMLESS TRANSITION FROM PRODUCT CONCEPT TO PRODUCTION AND DEPLOYMENT
Coyle, John, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 116-118; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Rapidly changing computing capabilities and simulation software have created the potential for an affordable product and process development protocol for new products. The concept of an Integrated Collocated product design team has already given way to an electronically collocated design team that functions in a synthetic environment without regard to company structure or national boundaries. The simulation and modelling toolset and supporting computational capabilities are exiting the twentieth century at a breath taking pace. The war fighting simulation models and distributed simulation tools have created the capability to experience near real engagements for tanks, ships and aircraft in a synthetic environment. Physics based simulation or products and processes are continuing to improve the modelling capability for synthetic test.
Derived from text
Product Development; Computerized Simulation; Virtual Reality; Systems Integration; Computer Aided Manufacturing

62
COMPUTER SYSTEMS

19960009084 Utrecht State Univ., Mathematical Inst.; **Netherlands**
PARALLEL ITERATIVE SOLUTION METHODS FOR LINEAR SYSTEMS ARISING FROM DISCRETIZED PDE'S
Vandervorst, Henk A., Utrecht State Univ., Netherlands; AGARD, Special Course on Parallel Computing in CFD; Oct 1, 1995, 39 p; In English; See also 19960009081; Avail: CASI; A03, Hardcopy; A03, Microfiche

In these notes we present an overview of a number of related iterative methods for the solution of linear systems of equations. These methods are so-called Krylov projection type methods and they include popular methods such as Conjugate Gradients, Bi-Conjugate Gradients, CGS, Bi-CGSTAB, QMR, LSQR and GMRES. We show how these methods can be derived from simple basic iteration formulas. Iterative methods are often used in combination with so-called preconditioning operators (approximations for the inverses of the operator of the system to be solved). Since these preconditioners are not essential in the derivation of the iterative methods, we will not give much attention to them in these notes. However, in most of the actual iteration schemes, we have included them in order to facilitate the use of these schemes in actual computations. For the application

of the iterative schemes one usually thinks of linear sparse systems, e.g., like those arising in the finite element or finite difference approximations of (systems of) partial differential equations. However, the structure of the operators plays no explicit role in any of these schemes, and these schemes might also successfully be used to solve certain large dense linear systems. Depending on the situation that might be attractive in terms of numbers of floating point operations. It will turn out that all of the iterations are parallelizable in a straight forward manner. However, especially for computers with a memory hierarchy (i.e., like cache or vector registers), and for distributed memory computers, the performance can often be improved significantly through rescheduling of the operations. We discuss parallel implementations, and occasionally we report on experimental findings.
Derived from text
Algorithms; Computation; Conjugate Gradient Method; Iterative Solution; Parallel Processing (Computers); Partial Differential Equations

19960009085 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. for Design Aerodynamics., Brunswick, Germany
STRUCTURED GRID SOLVERS 1: ACCURATE AND EFFICIENT FLOW SOLVERS FOR 3D APPLICATIONS ON STRUCTURED MESHES
Kroll, Norbert, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Radespiel, Rolf, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Rossow, CORD-C., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Special Course on Parallel Computing in CFD; Oct 1, 1995, 59 p; In English; See also 19960009081; Avail: CASI; A04, Hardcopy; A03, Microfiche

This lecture is devoted to the parallelization of block structured grid solvers for industrial applications. It is divided into two parts. Part 1 describes well established numerical algorithms with emphasis on spatial discretization and time stepping schemes. Attention is focused on the multigrid technique which is one of the most promising approaches to improve the efficiency of numerical methods. Finally, several large-scale computations are shown which demonstrate the ability of current block structured flow solvers. Part 2 of the lecture addresses various aspects of the parallelization of such flow solvers.
Author
Algorithms; Computational Fluid Dynamics; Finite Volume Method; Navier-Stokes Equation; Structured Grids (Mathematics); Three Dimensional Flow

19960009086 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Inst. for Design Aerodynamics., Brunswick, Germany
STRUCTURED GRID SOLVERS 2: PARALLELIZATION OF BLOCK STRUCTURED FLOW SOLVERS
Eisfeld, B., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Bleecke, H.-M., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Kroll, N., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; Ritzdorf, H., Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Special Course on Parallel Computing in CFD; Oct 1, 1995, 20 p; In English; See also 19960009081; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper reviews some general considerations on the parallelization of large block structured flow solvers for production use. Parallelization is therefore not treated as an isolated subject of research, but as a tool to increase the computational power for the user and as an integral part of the developmental environment of a CFD (computational fluid dynamics) code. As an example, the parallelization of the FLOWer code using the portable communications library CLIC-3D is given. Results of benchmark tests obtained on various computer hardware architectures demonstrate today's possibilities of parallel processing in CFD applications.
Author (revised)
Algorithms; Computational Fluid Dynamics; Interprocessor Communication; Parallel Processing (Computers); Structured Grids (Mathematics)

19960009087 Rensselaer Polytechnic Inst., Scientific Compuation Research Center., Troy, NY, United States
PARALLEL AUTOMATED ADAPTIVE PROCEDURES FOR UNSTRUCTURED MESHES
Shephard, M. S., Rensselaer Polytechnic Inst., USA; Flaherty, J. E., Rensselaer Polytechnic Inst., USA; Decougny, H. L., Rensselaer Polytechnic Inst., USA; Ozturan, C., Rensselaer Polytechnic Inst., USA; Bottasso, C. L., Rensselaer Polytechnic Inst., USA; Beall, M. W., Rensselaer Polytechnic Inst., USA; AGARD, Special Course on Parallel Computing in CFD; Oct 1, 1995, 49 p; In English; See also 19960009081
Contract(s)/Grant(s): NAG2-832; Avail: CASI; A03, Hardcopy; A03, Microfiche

Consideration is given to the techniques required to support adaptive analysis of automatically generated unstructured meshes on distributed memory MIMD parallel computers. The key areas of new development are focused on the support of effective parallel computations when the structure of the numerical discretization, the mesh, is evolving, and in fact constructed, during the computation. All the procedures presented operate in parallel on already distributed mesh information. Starting from a mesh definition in terms of a topological hierarchy, techniques to support the distribution, redistribution and communication among the mesh entities over the processors is given, and algorithms to dynamically balance processor workload based on the migration of mesh entities are given. A procedure to automatically generate meshes in parallel, starting from CAD geometric models, is given. Parallel procedures to enrich the mesh through local mesh modifications are also given. Finally, the combination of these techniques to produce a parallel automated finite element analysis procedure for rotorcraft aerodynamics calculations is discussed and demonstrated.
Author
Algorithms; Computational Fluid Dynamics; Grid Generation (Mathematics); Parallel Processing (Computers); Unstructured Grids (Mathematics)

19960009088 NASA Ames Research Center, Moffett Field, CA, United States
PARALLEL CFD ALGORITHMS ON UNSTRUCTURED MESHES
Barth, Timothy J., NASA Ames Research Center, USA; AGARD, Special Course on Parallel Computing in CFD; Oct 1, 1995, 41 p; In English; See also 19960009081; Avail: CASI; A03, Hardcopy; A03, Microfiche

The intent of these notes is to review several basic algorithms and procedures used in computational fluid dynamics (CFD) with emphasis on algorithms suitable to parallel computing environments. In particular, we concentrate on numerical methods in CFD which require the formation and solution of large sparse linear systems of algebraic equations. These matrices arise from the discretization of the Navier-Stokes equations which govern compressible fluid flow. From this point of view, a large portion of these notes addresses algorithms used in the formation, manipulation, and solution of sparse matrices on serial and parallel computers.
Derived from text
Algorithms; Compressible Flow; Computational Fluid Dynamics; Navier-Stokes Equation; Parallel Processing (Computers); Unstructured Grids (Mathematics)

19960009089 Colorado Univ., Dept. of Aerospace Engineering Sciences., Boulder, CO, United States
HIGH PERFORMANCE SIMULATION OF COUPLED NONLINEAR TRANSIENT AEROELASTIC PROBLEMS
Farhat, Charbel, Colorado Univ., USA; AGARD, Special Course on Parallel Computing in CFD; Oct 1, 1995, 79 p; In English; See also 19960009081; Prepared in cooperation with NASA. Langley Research Center, Hampton, VA
Contract(s)/Grant(s): NSF ASC-92-17394; NAG2-827; NAG1-5364; Avail: CASI; A05, Hardcopy; A03, Microfiche

The accurate prediction of aeroelastic phenomena such as divergence and flutter is essential in the design of high performance and safe aircraft. This prediction requires solving simultaneously the coupled fluid and structural equations of motion. Therefore numerical aeroelastic simulations are, in general, resource intensive. They belong to the family of Grand Challenge engineering problems and as such, can benefit from parallel processing technology. This paper highlights some important aspects of nonlinear computational aeroelasticity. These include a three-field arbitrary Lagrangian-Eulerian (ALE) finite element/volume formulation for coupled transient aeroelastic problems; a rigorous derivation of geometric conservation laws (GCLs) for flow problems with moving boundaries and unstructured deformable meshes; the design of a family of staggered procedures

for the efficient solution of the coupled fluid/structure partial differential equations; and fast parallel domain decomposition solvers. The derivations of the GCLs are presented for ALE based finite volume formulations as well as ALE based stabilized finite element methods. The impact of these GCLs on the numerical algorithms used for time-integrating the semi-discrete equations governing the structural and fluid mesh motions is also discussed. The solution of the governing three-field equations with mixed implicit/implicit and explicit/implicit staggered procedures are analyzed with particular reference to accuracy, stability, subcycling, distributed computing, I/O transfers, and parallel processing. A general and flexible framework for implementing the partitioned analysis of coupled transient aeroelastic problems with non-matching fluid/structure interfaces on heterogeneous and/or parallel computational platforms is also described. This framework and the staggered solution procedures are demonstrated with examples ranging from the numerical investigation on an iPSC-860 massively parallel processor of the instability of flat panels with infinite aspect ratio in supersonic airstreams, to the solution on the Paragon XP/S, Cray T3D and IBM SP2 parallel systems of three-dimensional wing response problems in the transonic regime.
Author (revised)
Aeroelasticity; Algorithms; Computational Fluid Dynamics; Nonlinear Systems; Parallel Processing (Computers)

19960016914 INETI, Lisbon, Portugal
A FAST PARALLEL COMPUTING MACHINE FOR REAL TIME DECISION MAKING: APPLICATIONS TO REAL TIME PROCESSING, WAR GAMES, FOREST FIRE AND FLUID DYNAMICS MODELS
Toste-Rego, Joao, INETI, Portugal; Dilao, Rui, Instituto Superior Tecnico, Portugal; Oct. 1995; 6p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The hardware prototype of a MIMD (multiple instruction multiple data) computing machine dedicated to the processing of large amounts of data in real time is described. The Lattice Automata Machine (LAM) is based on cellular automata architecture, but has extended features, for example, 'non-local' and 'time dependent' programming. The front end of LAM is hosted in a personal computer, used as an input/output peripheral. This machine has been developed for the dedicated programming of systems using partial differential equations and processes of up to 1.15 Giga events per second. One of the hardware characteristics introduced in this machine is the possibility of memory replication in different data banks, enabling the simultaneous access to different RAM positions.
Author
Decision Making; Parallel Processing (Computers); Real Time Operation; Automata Theory; Personal Computers; MIMD (Computers); Architecture (Computers); Computer Programming; Hardware

63 CYBERNETICS

19950025716 National Aerospace Lab., Amsterdam, Netherlands
MULTI-SENSOR DATA FUSION IN COMMAND AND CONTROL AND THE MERIT OF ARTIFICIAL INTELLIGENCE
Zuidgeest, Rene G., National Aerospace Lab., Netherlands; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 12 p; In English; See also 19950025702; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The human operator observing the real world is confronted with a huge amount of data from multiple sensor systems observing that world. Multi-sensor data fusion (MSDF) is one of the emerging fields in advanced information processing, concerned with fusing sensor data from these multiple sensor systems. Automated multi-sensor data fusion can help the operator by processing sensor data into concise and surveyable information that is more useful than each sensor system separately can provide. The merit of MSDF can be increased by employing the knowledge of the human operator about the real world, the sensor systems and the fusion process. With the aid of this knowledge, automated MSDF can assign meaning to sensor data and is able to reason about the observed world at a high level, comparable to what humans do. Artificial intelligence provides techniques to represent this knowledge and to reason with it. These techniques are discussed in the context of a generic framework comprising a world model and fusion processes. These techniques can contribute to an effective updating of the world model and can support its fusion processes. In addition, a global distributed fusion architecture based on the framework is proposed. As specific domain of fusion, battlefield surveillance is considered. This paper shows the potential use of artificial intelligence in multi-sensor data fusion.
Derived from text
Artificial Intelligence; Command and Control; Expert Systems; Information Systems; Multisensor Applications; Multisensor Fusion; Surveillance; Technology Assessment

19950025717 Siemens A.G., Defence Electronics., Unterschleisheim, Germany
AIDEX: AN EXPERT SYSTEM FOR AIRCRAFT IDENTIFICATION
Ebmeyer, J., Siemens A.G., Germany; Freyler, H., Siemens A.G., Germany; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 4 p; In English; See also 19950025702; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

The AIDEX (Advanced Identification Expert System) is the first expert system developed for aircraft identification providing a knowledge-based fusion of identification data from various sensors and identification sources.
Derived from text
Aircraft Detection; Artificial Intelligence; Expert Systems; IFF Systems (Identification); Information Systems; Knowledge Bases (Artificial Intelligence); Man Machine Systems; Multisensor Fusion

19950025718 UNISYS GSG Canada, Inc., Montreal Quebec, Canada
ARCHITECTURE AND IMPLEMENTATION OF A MULTI-SENSOR DATA FUSION DEMONSTRATION MODEL WITHIN THE REAL-TIME COMBAT SYSTEM OF THE CANADIAN PATROL FRIGATE
Begin, F., UNISYS GSG Canada, Canada; Boily, E., UNISYS GSG Canada, Canada; Mignacca, T., UNISYS GSG Canada, Canada; Shahbazian, E., UNISYS GSG Canada, Canada; Valin, P., UNISYS GSG Canada, Canada; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 8 p; In English; See also 19950025702; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The research and development (R&D) group at UNISYS Government Systems Group (GSG) Canada is working on a demonstration model of a multi-sensor data fusion (MSDF) implementation for the Canadian Patrol Frigate (CPF). The conditions are made very realistic by the use of the Software Test and Development Facility (STDF) situated on the premises in Montreal. The paper describes the implementation design of the system. More emphasis is put on the architecture of both the simulation and the fusion systems. The fusion system is divided into four processes: Information Management (IM), Multi-Sensor Data Fusion (MSDF), Performance Evaluation (PE) and Display Management (DM). Each process within the fusion system is outlined.
Derived from text
Architecture (Computers); Canada; Computer Systems Design; Mathematical Models; Multisensor Applications; Multisensor Fusion; Real Time Operation; Remote Sensors; Software Engineering; Weapon Systems

19950026074 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
AN ORIGINAL NUMERICAL METHOD FOR AUTONOMOUS NAVIGATION *UNE METHODE NUMERIQUE ORIGINALE POUR LA NAVIGATION AUTONOME*
Cantalloube, Hubert, Office National d'Etudes et de Recherches Aerospatiales, France; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 9 p; In French; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A original numerical method associated with classical filtering techniques, image treatment techniques, and the evidence theory is proposed for the automatic engine navigation. The ambiguous

observations (confusing reference marks, false alarms, and nondetections) are tolerated. The effectiveness of the algorithm is illustrated with a concrete example.
Transl. by CASI
Artificial Intelligence; Automatic Pilots; Autonomous Navigation; Decision Theory; Expert Systems; Imaging Techniques; Inertial Navigation; Numerical Analysis

19960008190 Hebrew Univ., Dept. of Applied Physics., Jerusalem, Israel
THE EMERGING FIELD OF ARTIFICIAL NEURAL NETWORKS AND THEIR OPTOELECTRONIC IMPLEMENTATIONS
Agranat, Aharon J., Hebrew Univ., Israel; AGARD, Optical Processing and Computing; Sep 1, 1995, 20 p; In English; See also 19960008186; Avail: CASI; A03, Hardcopy; A02, Microfiche

Artificial neural networks based on models which were developed in the context of brain research are becoming a significant data processing tool. Neural computing algorithms are robust, parallel, can be trained from examples, and perform associative memory recall. Special purpose hardware is essential for implementing these algorithms effectively. Combined optoelectronic implementations of these models seem to be the preferred embodiments. Two approaches for implementing artificial neural networks by a combined optoelectronic systems will be described: the optical disk based artificial neural networks and the electroholographic artificial neural networks.
Author
Holography; Neural Nets; Optical Data Processing; Optical Disks; Optoelectronic Devices

19960012290 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
KNOWLEDGE-BASED FUNCTIONS IN AEROSPACE SYSTEMS *SYSTEMES DE GUIDAGE ET DE PILOTAGE AEROSPATIAUX A BASE DE SYSTEMES EXPERTS*
Nov 1, 1995; 150p; In English, 6-7 Nov. 1995, Madrid, Chatillon, Moffett Field, CA, Spain, France, USA; See also 19960012291 through 19960012296
Report No.(s): AGARD-LS-200; NIPS-96-07993; ISBN 92-836-1026-1; Avail: CASI; A07, Hardcopy; A02, Microfiche

In aerospace systems classical control technology has enabled the transfer of functions of the human operator to machines which need not be based on the explicit evaluation of knowledge. Symbolic data processing, neural networks and the techniques of artificial intelligence now permit the design of automatic systems which can explicity make use of knowledge stored in computers. The Lecture Series presents a conceptual framework for the automation of knowledge-based control and management functions in aerospace systems, which are usually carried out by human operators. It describes the structure of these functions, discusses successful examples of application and gives recommendations for further studies.
Author
Aerospace Systems; Air Traffic Control; Automatic Control; Conferences; Control Systems Design; Expert Systems; Flight Control; Knowledge Bases (Artificial Intelligence)

19960012291 Draper (Charles Stark) Lab., Inc., Cambridge, MA, United States
FUNCTIONAL ANALYSIS/DECOMPOSITION OF CLOSED-LOOP, REAL-TIME WORK PROCESSES
Adams, Milton B., Draper (Charles Stark) Lab., Inc., USA; AGARD, Knowledge-Based Functions in Aerospace Systems; Nov 1, 1995, 10 p; In English; See also 19960012290; Avail: CASI; A02, Hardcopy; A02, Microfiche

Performing a functional analysis is the first step in developing a solution to a complex problem. The functional analysis of a generic complex, real-time, closed-loop process presented here serves to establish a common framework and a common language for describing a variety of specific guidance and control related processes. The two principal components of a functional analysis are (1) a functional decomposition and (2) a detailed description of the information flow contained in the interfaces between the individual functions comprising that decomposition. The approach taken here is the classical structured analysis with a dataflow representation. A dataflow representation has been chosen because it readily lends itself to a hierarchical description. That is, each individual function can be further decomposed into more refined subfunctions which, when taken together, have combined inputs and outputs which are consistent with those of the original function. Neither control flow representations nor object oriented analysis is addressed.
Derived from text
Feedback Control; Functional Analysis; Information Flow; Planning

19960053057 Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen, Germany
NEURAL NETWORK TECHNIQUES FOR MISSILE GUIDANCE AND CONTROL
Krogmann, U. K., Bodenseewerk Geraetetechnik G.m.b.H., Germany; Jun. 1996; 12p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The present paper deals with the application of artificial neural networks for flight guidance and control. After an introduction to the problem, the structure and functioning of feed-forward neural networks, the transient response and the learning mechanism for these networks is examined. This is followed by the development of the structure of the flight guidance and control loop with neural networks. The neuronal flight controller is not programmed but first learns the knowledge needed for stable flight guidance and control in a separate training and learning phase and hen continues learning in the actual utilization phase. For a typical missile as a concrete example, the neural controller is trained and tested in a simulated utilization phased. On the whole, a good to very good control behavior is achieved with the time-variant, non-linear control plant. This paper shows a new way of implementing reliable, non-linear learning autopilots which can be realized in hardware as parallel signal processing modules.
Author
Automatic Pilots; Transient Response; Signal Processing; Parallel Processing (Computers); Neural Nets; Missile Control; Flight Control

19970001703 Sheffield Univ., Dept. of Mechanical Engineering, United Kingdom
USE OF NEURAL NETWORKS/GENETIC ALGORITHMS FOR FAULT DETECTION AND SENSOR LOCATION
Tomlinson, G. R., Sheffield Univ., UK; Worden, K., Sheffield Univ., UK; Staszewski, W., Sheffield Univ., UK; Smart Structures and Materials: Implications for Military Aircraft of New Generation; Oct. 1996; 6p; In English; See also 19970001697; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

An approach to fault detection and sensor location using neural networks and genetic algorithms is described. A plate representing an aircraft panel is used as the structure and static strains, derived from a Finite Element model of the plate, are used as the supervised training set for the neural network. Having established a suitable diagnostic network, the process of optimal sensor location is carried out using a genetic algorithm for the diagnostic system. The final part of the paper briefly describes a new approach to fault detection using Novelty Measures which removes the need to use a supervised learning approach, common to most classical neural network procedures.
Author
Aircraft Structures; Fault Detection; Finite Element Method; Genetic Algorithms; Panels; Smart Structures; Shape Memory Alloys; Position (Location)

19970012591 Sener Ingenieria y Sistemas S.A., Madrid, Spain
GREY LEVEL SEGMENTATION WITH SELECTABLE NUMBER OF DISCRIMINATION LEVELS USING HOPFIELD-LIKE NEURAL NETWORKS WITH CONSTRAINT SATISFACTION CRITERIA
Domingo, Alberto, Sener Ingenieria y Sistemas S.A., Spain; Santamaria, Javier, Sener Ingenieria y Sistemas S.A., Spain; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 167-174; In English; See also 19970012579; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A method is proposed for grey-level image segmentation which combines the benefits of an Artificial Neural Network (ANN) approach with the definition of simple, intuitive constraints that govern the network behaviour. Several schemes are introduced for the definition of the constraints, as well as for the network potential initialization criteria. A new neural network model, derived from the Hopfield Neural

Net, is proposed, adapted to the defined constraints. Obtained results are shown and compared with those achieved with classical algorithms.
Derived from text
Imaging Techniques; Neural Nets; Segments

19970012599 National Aerospace Lab., Amsterdam, Netherlands
MULTI-SENSOR DATA FUSION IN COMMAND AND CONTROL AND THE MERIT OF ARTIFICIAL INTELLIGENCE
Zuidgeest, Rene G., National Aerospace Lab., Netherlands; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 284-294; In English; See also 19970012579; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The human operator observing the real world is confronted with a huge amount of data from multiple sensor systems observing that world. Multi-Sensor Data Fusion (MSDF) is one of the emerging fields in advanced information processing, concerned with fusing sensor data from these multiple sensor systems. Automated multi-sensor data fusion can help the operator by processing sensor data into concise and surveyable information, that is more useful than every sensor system separately can provide. The merit of MSDF can be increased by employing the knowledge of the human operator about the real world, the sensor systems and the fusion process. With the aid of this knowledge, automated MSDF can assign meaning to sensor data and is able to reason about the observed world at a high level, comparable to what humans do. Artificial intelligence provides techniques to represent this knowledge and to reason with it. These techniques are discussed in the context of a generic framework comprising a world model and fusion processes. These techniques can contribute to an effective updating of the world model and can support nS fusion processes. In addition, a global distributed fusion architecture based on the framework is proposed. As specific domain o fusion, battlefield surveillance is considered. This paper shows the potential use of artificial intelligence in multi-sensor data fusion.
Derived from text
Command and Control; Multisensor Applications; Data Bases; Artificial Intelligence

19970030250 Naval Postgraduate School, Dept. of Aeronautics and Astronautics, Monterey, CA United States
INTRODUCTION TO NEURAL NETWORKS BASIC THEORY AND APPLICATION POTENTIAL FOR MISSION SYSTEMS
Collins, Daniel J., Naval Postgraduate School, USA; Sep. 1997; 12p; In English; See also 19970030248; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This lecture is a brief introduction to neural networks. Modern approaches to complex engineering problems typically involve the development of a computer algorithm with a specified set of inputs. For a well posed problem the inputs specify a unique output or solution. Thus for the state variable linear quadratic problem in control theory with the plant specified one uses a Riccati equation to obtain a set of unique feedback gains.
Author
Neural Nets; Algorithms; Control Theory

19970030252 Centre National de la Recherche Scientifique, Paris, France
HYBRID ARCHITECTURES FOR INTELLIGENT SYSTEMS, LEARNING INFERENCE SYSTEMS
Bouchon-Meunier, B., Centre National de la Recherche Scientifique, France; Sep. 1997; 10p; In English; See also 19970030248; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Fuzzy systems are very efficient since they are generally based on expert knowledge, they are very robust and flexible and they manage interpretable knowledge. The main problem in their construction is the tuning of all the parameters involved in their construction: shapes and parameters of membership functions, numbers of classes in fuzzy partitions of the universes of definition of variables (number of available characterizations for each variable), number of rules, values of the rule conclusions when they are crisp. While it is interesting to allow the designer of the fuzzy system to make some of the choices, the automatic tuning of the other parameters is a valuable help. In the case where training sets of data are available, it is possible to use automatic methods for the learning part of a fuzzy system. Neural networks are powerful for learning. We present the main complementary utilization of these techniques. WE have treated separately genetic algorithms. Finally, we show that special types of fuzzy systems themselves can be considered as learning systems.
Derived from text
Neural Nets; Fuzzy Systems; Genetic Algorithms; Artificial Intelligence

19970030253 Defence Research Agency, Farnborough, United Kingdom
DUAL WAVEBAND INFRA-RED TARGET TRACKING AND ACQUISITION SYSTEM
Bernhardt, M., Defence Research Agency, UK; Welch, M., Defence Research Agency, UK; Toulson, D. L., London Univ., UK; Sep. 1997; 14p; In English; See also 19970030248; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The introduction of Infra-Red (IR) systems onto military fast-jet platforms, particularly Forward Looking Infra-Red (FLIR) has extended the operational envelope of these aircraft by giving them a night flying capability. FLIR systems commonly use the 8-12 micron wavelength band of the IR spectrum as this is part of the IR spectrum where there is good atmospheric transmission. Conveniently, objects at room temperature have peak IR emissions within this band too. Some FLIR systems use the 3-5 micro band, which also has good atmospheric transmission and where hotter objects, such as aircraft exhaust plumes, have their peak emission. In this paper we describes an ATR system using FLIR imagery which has the following features: 1. it uses two wavebands of digital FLIR imagery simultaneously to extract additional scene information by data fusion; 2. it is designed to work for targets that occupy only a few pixels in the image; 3. it uses a neural network for initial clutter rejection; 4. it uses a novel probabilistic tracking methodology; 5. it uses a committee of neural networks for final confirmation of targets, and 6. it is being evaluated on real flight trials data. The structure of this paper is as follows: a brief outline of a simple ATR process and discribes its limitations; a discussion about the improved architecture, its extension to two wavebands of FLIR imagery and the novel aspects of the neural networks and their training; a discussion the preliminary results and ongoing evaluation; a number of novel enhancements to the neural networks that have been investigated, and conclusion and summarizes the paper.
Derived from text
Infrared Tracking; Targets; Tracking (Position); Neural Nets

19970030254 Naval Postgraduate School, Dept. of Aeronautics and Astronautics, Monterey, CA United States
APPLICATION OF NEURAL NETWORK TO RECONFIGURATION OF DAMAGED AIRCRAFT
Collins, Daniel J., Naval Postgraduate School, USA; Sep. 1997; 15p; In English; See also 19970030248; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Although the title of this lecture refers to using Artificial Neural Networks (ANN) in reconfiguration algorithms of damaged aircraft, the analysis applies in general to the identification and control of non-linear time-varying dynamical systems. This lecture addresses the problem of emulation and control of a fighter aircraft by means of ANN. Four models for describing non-linear MIMO dynamical systems are described. Based on this description a combined feedforward and recurrent neural network is structured to emulate the system. A procedure is given to emulate multiple systems in a single neural network. By the introduction of a minimal realization of the network, the complexity of the network is greatly reduced without degradation of the operating performance of the network. The aircraft model used in the demonstration of the neural network is the longitudinal node of the F/A-18A fighter aircraft. The work developed here is based on Shakar Dror.
Author
Damage; Fighter Aircraft; Algorithms; Nonlinearity; Dynamical Systems; Aircraft Models; Aircraft Control

19970030255 Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen, Germany
TOWARDS AUTONOMOUS UNMANNED SYSTEMS
Krogmann, U., Bodenseewerk Geraetetechnik G.m.b.H., Germany; Sep. 1997; 22p; In English; See also 19970030248; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The development, procurement and utilization of defense systems will in future be strongly influenced by affordability. A consid-

erable potential for cost reduction is seen in the extended use of unmanned systems. This paper will describe important enabling techniques and technologies as a prerequisite for the implementation of future autonomous systems with goal- and behavior-oriented features. Main emphasis is being placed on information technology with its soft-computing techniques. The treatment of conceptional system approaches will be followed by design considerations and then a global methodology for the engineering of future autonomous systems will be dealt with. Critical experiments for technology evaluation and validation will be mentioned together with a brief description of the main focus in future research.
Author
Unmanned Spacecraft; Cost Reduction; Defense Industry; Technologies; Autonomy

19980016573 National Inst. of Standards and Technology, Intelligent Systems Div., Gaithersburg, MD United States
TECHNOLOGY REQUIREMENT TO IMPLEMENT IMPROVED SITUATION AWARENESS: MACHINE PERCEPTION
Albus, James S., National Inst. of Standards and Technology, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 8p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Situation awareness is the ability of an unmanned vehicle intelligent control system to model the world. A world model is an intelligent system's current internal estimate of the state of the world, plus its prior knowledge of the history of the world, plus knowledge about the rules of physics and mathematics, plus rules of behavior, task skills, and basic values. World modeling is the ability of the intelligent system to maintain and use a world model to predict and filter sensory experience, to understand the past, and to simulate the future. Perception is the functional transformation of data from sensors into situational awareness.
Author
Mathematical Models; Human Factors Engineering; Artificial Intelligence; Decision Making; Machine Learning; Decision Support Systems

19980206033 NASA Lewis Research Center, Cleveland, OH United States
VIBRATIONAL ANALYSIS OF ENGINE COMPONENTS USING NEURAL-NET PROCESSING AND ELECTRONIC HOLOGRAPHY
Decker, Arthur J., NASA Lewis Research Center, USA; Fite, E. Brian, NASA Lewis Research Center, USA; Mehmed, Oral, NASA Lewis Research Center, USA; Thorp, Scott A., NASA Lewis Research Center, USA; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The use of computational-model trained artificial neural networks to acquire damage specific information from electronic holograms is discussed. A neural network is trained to transform two time-average holograms into a pattern related to the bending-induced-strain distribution of the vibrating component. The bending distribution is very sensitive to component damage unlike the characteristic fringe pattern or the displacement amplitude distribution. The neural network processor is fast for real-time visualization of damage. The two-hologram limit makes the processor more robust to speckle pattern decorrelation. Undamaged and cracked cantilever plates serve as effective objects for testing the combination of electronic holography and neural-net processing. The requirements are discussed for using finite-element-model trained neural networks for field inspections of engine components. The paper specifically discusses neural-network fringe pattern analysis in the presence of the laser speckle effect and the performances of two limiting cases of the neural-net architecture.
Author
Neural Nets; Structural Vibration; Engine Parts; Holography; Damage Assessment; Real Time Operation; Inspection; Mathematical Models; Artificial Intelligence

19990014363 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
MACHINE PERCEPTION
Onken, R., Advisory Group for Aerospace Research and Development, France; Dickmanns, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 59-61; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

A general discussion of machine perception and the concept of "conscious machines" is presented. Technology assessment, current and future applications pertaining to these technologies and the feasibility of these applications are discussed.
CASI
Machine Learning; Artificial Intelligence; Automata Theory; Consciousness

19990014373 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
ADVANCES IN SUPPORTING TECHNOLOGIES
Krogman, U., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 83-87; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

It can be stated that significant changes are currently taking place in the new IT and MT regarding functional capabilities, performance, characteristics and cost. These changes will influence the user and the supporting industries' organizational structure. The rate of change and related realizations will exceed normal evolution and will have great social impacts accompanying the technological and functional advances. In order to accommodate this, the strategies of users and industry must be adapted accordingly.
Derived from text
Information Systems; Information Transfer; Communication Networks; Software Engineering; Machine Learning; Microminiaturized Electronic Devices

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NUMERICAL ANALYSIS

19950027633 Laboratoire de Medecine Aerospatiale, Bretigny-sur-Orge, France
ANTI-G SUITS
Clere, J. M., Laboratoire de Medecine Aerospatiale, France; Ossard, G., Laboratoire de Medecine Aerospatiale, France; Kerguelen, M., Laboratoire de Medecine Aerospatiale, France; AGARD, Current Concepts on G-Protection Research and Development; May 1, 1995, 8 p; In English; See also 19950027629; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Several improvements were carried out on the anti-G suits and on the anti-G valves. These improvements should enhance G tolerance and pilot effectiveness under G. Most of these improvements need to be applied in operational use and not be simply reserved for the research world. In order to achieve this, these new anti G equipments must be the least cumbersome and intensive for pilots and efforts must be made to ensure their acceptability.
Derived from text
Acceleration Protection; Flight Clothing; Physiological Effects; Pressure Suits; Pressurizing

19970010679 Alenia Spazio S.p.A., Turin, Italy
GLOBAL/LOCAL ANALYSIS IN FINITE ELEMENT TECHNOLOGY
Marchese, P., Alenia Spazio S.p.A., Italy; Gualtieri, N., Alenia Spazio S.p.A., Italy; Augello, G., Alenia Spazio S.p.A., Italy; Oct. 1996; 16p; In English; See also 19970010666; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

In the design and verification of complex structures the global analysis gives the internal load paths, whereas the local analysis computes stresses and strains. These analyses are performed using classical methods, the Finite Element Analysis (FEA), or a combination of both. The outstanding development in the finite element methodology and the explosion in computer hardware capability led to direct applications of the FEA techniques to global and local analyses, with reduction of computation time and improvement in the results accuracy. This paper explores some of the FEA practices currently in use, focusing on work presently being performed in Alenia Spazio.
Author
Finite Element Method; Structural Analysis; Computational Grids; Complex Systems

66
SYSTEMS ANALYSIS

19950023183 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France
RECENT ISSUES AND ADVANCES IN AEROMEDICAL EVACUATION (MEDEVAC) ***LES PROGRES RECENTS ET LES QUESTIONS POSEES DANS LE DOMAINE DE L'EVACUATION AEROMEDICALE (MEDEVAC)***
Feb 1, 1995; 132p; In English, 3-7 Oct. 1994, Athens, Greece; See also 19950023184 through 19950023208
Report No.(s): AGARD-CP-554; ISBN 92-836-1012-1; Copyright Waived; Avail: CASI; A07, Hardcopy; A02, Microfiche

Recent experience has demonstrated NATO's difficulty in planning and coordinating International Aeromedical Evacuation of acutely sick, injured and wounded patients. There is much discussion which seeks to clarify and define NATO's role in medical air evacuation. Papers in this Symposium updated available data in medicine research and development and provided a focal point for discussion of specialized equipment and techniques required to care for patients in the NATO Medevac System. The Symposium covered also the role, training, procedures as well as command and control in the management of casualties in the aeromedical evacuation system. There is a clear operational need to provide medical planners within NATO and Alliance Nations with a generic concept of integrated aeromedical evacuation to improve the effectiveness of NATO forces.
Air Transportation; Casualties; Conferences; Evacuating (Transportation); Medical Services; North Atlantic Treaty Organization (NATO)

19950023184 Department of the Air Force, Transportation Command., Scott AFB, IL, United States
USE OF QUALITY TOOLS TO RE-ENGINEER THE AEROMEDICAL EVACUATION (AE) SYSTEM
Bloomquist, Carroll R., Department of the Air Force, USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 4 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The element of change pervades each of our activities; defining change should be accomplished in a logical fashion using definitive tools. A number of quality tools are available to produce rational, well-defined change in a large complex system. One of these methods, the Theory of Constraints (TOC) will be the focus of this paper with regard to designing and implementing change for the USA (U.S.) Department of Defense (DOD) aeromedical evacuation (AE) system. Improvements in the U.S. AE system may provide a systemic benefit to multinational operations.
Author
Air Transportation; Evacuating (Transportation); Medical Equipment; Medical Services; Tools

19950023185 Canadian Forces Air Command, Winnipeg Manitoba, Canada
THE CANADIAN EXPERIENCE IN UN AIREVAC SARAJEVO AIRLIFT: APRIL 1993-OCTOBER 1994
Read, Julia M., Canadian Forces Air Command, Canada; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 6 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

For the first time since the Korean Conflict, Canadian aeromedical evacuation (airevac) crews have been deployed to a theater of war. While certainly not of the same magnitude as the Korean operation, this deployment has helped us re-learn some of the lessons forgotten in the intervening 40 years, and has reinforced the readiness posture for which we have trained. The vagaries of emergency airlift have brought our airevac mission very clearly into focus.
Author
Air Transportation; Canada; Evacuating (Transportation); Medical Personnel; Medical Services

19950023186 Department of the Air Force, Shaw AFB, SC, United States
UNITED NATIONS AEROMEDICAL EVACUATION OPERATIONS IN THE FORMER YUGOSLAVIA
Thornton, W. P., Department of the Air Force, USA; Neubauer, J. C., Department of the Air Force, USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 8 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper examines intratheater aeromedical evacuation of United Nations Protection Force (UNPROFOR) casualties during peacekeeping operations in the republics of Croatia, Bosnia-Hercegovina, and the Former Yugoslav Republic of Macedonia. Its purpose is to inform NATO countries that participate in future UN operations of the inherent deficiencies of the force medical support for such multinational missions. UNPROFOR consists of over 40,000 personnel representing 36 nations organized into at least 37 battalion size units in a widely dispersed deployment. The paper is a summary of observations from the HQ, UNPROFOR Medical Branch compiled from reports, liaison visits to units, and direct participation in planning and training activities for aeromedical evacuation. Effective aeromedical evacuation in this mission was complicated by many factors: lack of dedicated aeromedical evacuation units; difficult weather and terrain; restrictions of flight imposed by warring factions; lack of standardized communications and medical equipment; wide variation in the level of proficiency, training, and experience of various contingents; and lack of standardized international procedures and policies. There is no medical unit in theater to bridge the gap between first level medical units in the field and the level three field hospitals. Accordingly, most NATO member contingents have elected to place field surgical teams at the battalion level. Discussion includes capabilities provided by military and civilian utility helicopter and fixed-wing aircraft. Efforts in training and simplification of procedures for evacuation are also summarized. The limitations of the current system are described, and existing shortfalls are defined with recommendations for future improvements.
Author
Air Transportation; Evacuating (Transportation); Medical Services; United Nations; Yugoslavia

19950023187 Royal Netherlands Air Force, The Hague, Netherlands
CIVIL MILITARY CO-OPERATION: A TEN YEAR EXPERIENCE OF AN AFFILIATIVE AEROMEDICAL EVACUATION PROGRAMME OF THE NETHERLANDS ARMED FORCES AND A CIVILIAN REPATRIATION ORGANIZATION
Vanlousden, A. J., Royal Netherlands Air Force, Netherlands; Rutten, F., University Hospital, Netherlands; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 3 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The increase in the number of peace-keeping activities of the armed forces, and the continuing pressure on national defense budgets, are making a demand for maximum efficiency. Triservice co-operation between army, navy and airforce is being pushed in all areas (not just in the medical area), as well as international co-operation between services and civil-military co-operation.
Derived from text
Air Transportation; Evacuating (Transportation); Medical Services; Netherlands

19950023188 Royal Netherlands Air Force, The Hague, Netherlands
AEROMEDICAL EVACUATION BY RNLAF - WORK ACCORDING TO PROTOCOL
Vandermeulen, Robert P., Royal Netherlands Air Force, Netherlands; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 2 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

In this presentation the benefit of using a protocol will be clarified. For some two years now the Royal Netherlands Air Force uses a protocol with respect to the following three items: Requesting a Medevac, Selecting the Medical Equipment and Medical crew and Evaluation Rapportation. The protocol enhances the simplicity and flexibility of aeromedical evacuation.
Derived from text
Air Transportation; Evacuating (Transportation); Medical Services; Netherlands

19950023189 Hospital del Aire, Madrid, Spain
CRITICAL EVALUATION OF AEROMEDICAL EVACUATION IN A MULTINATIONAL FORCES SCENARIO
Navarro-Ruiz, V., Hospital del Aire, Spain; Peralba-Vano, J. I., Hospital del Aire, Spain; Sanchez-Sanchez, Z. G., Hospital del Aire, Spain; Rios-Tejada, F., Hospital del Aire, Spain; Miles, P., Hospital del Aire,

Spain; Alonso-Rodriguez, C., Hospital del Aire, Spain; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 3 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

A little more than hundred years ago, the injured soldiers were left behind in the battlefield and it was not extraordinary to see wounded still being picked up days after the battle, and then to receive, if they were lucky, only some degree of wound care and lifesaving amputations. Everyone is aware of the changes that have occurred in our society following the scientific achievements of the last century. These technical advances have changed the view of our planet. For the first time we realize not only that we are in the same boat, but that we can change its course. Medicine has not turned its back to these changes. Today's therapeutic possibilities are far beyond the expectations present just a few decades ago. Those can be made available to any wounded or sick, thanks the progress in transportation, mainly air transportation and medical airevacuation. However, two facts have to be taken into account: (1) Warfare, with its everchanging situation and hi-tech weapon systems has developed an enormous destruction potential; (2) Medicine, has become more complex and has to face limited health resources in the military and civilian environment. Medical care and treatment are expensive, complicated and this applies also to med-evac media, especially the ones involved in aeromedical evacuation. Bearing all this in mind, we describe problems encountered with airevacuations during our involvement in multinational forces and make recommendations after their analysis.
Derived from text

Air Transportation; Casualties; Evacuating (Transportation); Medical Services

19950023190 SEU-061, Madrid, Spain
EXPERIENCE IN HELICOPTER AEROEVACUATION IN THE COMMUNITY OF MADRID, SPAIN
Cepas, J., SEU-061, Spain; Delpozo, C., SEU-061, Spain; Hernandez, C., SEU-061, Spain; Aparicio, J., SEU-061, Spain; Lopez, J. A., SEU-061, Spain; Romero, M., SEU-061, Spain; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 4 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

It's now well-known the fact that in the last few years a new concept of trauma patient medical assistance is imposing itself in the field of emergency medicine. This is helicopter aeroevacuation, and this together with the appropriate coordination between pre-hospital medical care and intensive care units, is making important changes in the disease and death toll of this kind of patients. The objective of this talk is to transmit the experience of this pre-hospital care service and to evaluate its results and evolution in its first three years of life.
Author

Air Transportation; Evacuating (Transportation); Helicopters; Medical Services; Patients; Spain

19950023191 Human Systems Div., Brooks AFB, TX, United States
AEROMEDICAL EVACUATION IN COMBINED OPERATIONS
Belihar, Robert P., Human Systems Div., USA; Brannon, Robert H., Human Systems Div., USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 2 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The Gulf War (Desert Shield/Desert Storm) was a military effort involving multinational participation on a scale unparalleled in the history of modern warfare. Numerous countries were involved in the operation--many providing combatants. The nature and scope of the allied involvement led to numerous interoperability issues in many areas, including medical. USA forces were deployed in accordance with an existing operational plan (OPLAN) which had been developed to counter an Iraqi threat to Kuwait and Saudi Arabia. That OPLAN included the development of a theater medical system (TMS) to support all components of the U.S. military. The details of the relationship between U.S. forces and its allies were not part of that OPLAN and evolved as deployment of forces took place. In order to resolve interoperability issues, Friendly Force Medical Conferences were conducted during the course of the war. Senior medical officers from the allied forces gathered together to resolve areas of concern. There was considerable variation in the medical capabilities of the deployed allied forces--particularly related to aeromedical evacuation.
Derived from text

Air Transportation; Evacuating (Transportation); Medical Services; Warfare

19950023192 Vaerloese Air Base, Medical Squadron 590., Vaerloese, Denmark
DANISH AEROMEDICAL EVACUATION EFFORTS DURING THE GULF WAR
Lyduch, S., Vaerloese Air Base, Denmark; Nielsen, J. Nybo, Vaerloese Air Base, Denmark; Larsen, F. K., Vaerloese Air Base, Denmark; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 3 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

During the Gulf War 1990/1991 a Boeing 737-300 was leased from a civilian airline company and prepared for aeromedical evacuation of injured allied soldiers from U.S. bases in Saudi Arabia, or from staging facilities in West Germany or England, to Holstebro Military Hospital in Denmark. Additional fuel tanks and military communication, navigational and identification systems were installed. The original interior was replaced with stretcher racks placed along the cabin wall on both sides together with intensive care medical monitoring equipment. Object was to operate 24 hours a day, and three medical crews were established. Patient selection, categorization, prioritization and loading plans would be decided by a Senior Flight Surgeon in a forward position. After 3 weeks, on February 8, 1991 the system was declared operational, and a test flight to Rhein Main AB, Germany was accomplished. Though the system was never activated due to the limited number of casualties, valuable experience was gained, and the system should be considered in connection with future international military operations.
Author

Air Transportation; Boeing 737 Aircraft; Evacuating (Transportation); Medical Equipment; Medical Personnel; Medical Services; Warfare

19950023193 Hospital del Aire, Madrid, Spain
EXPERIENCES LEARNED FROM THE SPANISH ARMED FORCES AEROMEDICAL EVACUATION SYSTEM IN THE FORMER YUGOSLAVIA
Sanchez-Sanchez, Z. G., Hospital del Aire, Spain; Peralba-Vano, J. I., Hospital del Aire, Spain; Miles, P., Hospital del Aire, Spain; Rios-Tejada, F., Hospital del Aire, Spain; Navarro-Ruiz, V., Hospital del Aire, Spain; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 4 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

During the last two years, Spain has participated as a part of the United Nations Forces in the former Yugoslavia. The Spanish Forces bore a major responsibility for maintaining the access of relief personnel and supplies to the areas designated to them, especially around Mostar and the Neretva valley. Medical personnel from the Army accompanied these forces establishing certain sanitary objectives and implementing their medical deployment plans. These plans consisted of a small classification post in Dracevo with an ICU with surgical Unit (1 Surgeon, 1 Orthopedist, 1 Anesthesiologist, 1 Intensivist, etc.) a few hospital beds and 4 ambulance teams, each with a doctor and a nurse on board. As the first casualties occurred, the aeromedical evacuation plan was activated (this task was 'commended' to the Air Force Med-Evac Teams). These teams had had some relatively recent experience drawn from operations in Namibia and south-west Asia in the last years. But the real scenario, taught new lessons which had to be assimilated, and the conclusions drawn implemented to improve our operational activity.
Author

Air Transportation; Armed Forces (Foreign); Evacuating (Transportation); Medical Equipment; Medical Services; Yugoslavia

19950023194 Department of the Air Force, Office of the Command Surgeon., Scott AFB, IL, United States
RE-ENGINEERING SUPPORT TO THE PATIENT MOVEMENT PROCESS
Power, John D., Department of the Air Force, USA; Frank, William P., Department of the Air Force, USA; Mahlum, Phillip, Department of the Air Force, USA; Simpson, Jack, II, Department of the Air Force, USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation

(MEDEVAC); Feb 1, 1995, 3 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The complexity and dynamics of medical evacuation planning - for peacetime, wartime, and disaster scenarios - require decision support aids that provide much more than data base access and spreadsheet solutions. This paper presents an overview of the development and early user operational and technical assessment of a Decision Support System (DSS) that incorporates innovative object-oriented data bases, state-of-the-art mapping capability, and constraint-directed planning technology.

Author

Decision Making; Evacuating (Transportation); Management Methods; Medical Services; Patients

19950023195 Royal Norwegian Inst. of Aviation Medicine, Oslo, Norway

THE IMPACT OF OCCUPATIONAL CULTURES ON COORDINATION OF EMERGENCY MEDICAL SERVICE CREW

Fonne, V. M., Royal Norwegian Inst. of Aviation Medicine, Norway; Myhre, G., Royal Norwegian Inst. of Aviation Medicine, Norway; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 7 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

The purpose of the study was to see whether one can observe different occupational cultures in the Emergency Medical Service and whether these differences in orientation among the crewmembers may have an impact on effective crew coordination. The number of crew members is usually limited to pilot, paramedic rescuer and medical doctors or registered nurse. Due to their different professional training, each crew member joins the Emergency Medical Service (EMS) with different backgrounds, interests and expectations. The operational stresses of this kind of service, however, demand team work and expose the crew's ability to coordinate their actions to work as a team. The initial study consisted of 60 operational crewmembers from the Norwegian Air Ambulance Service. They represent 65 percent of the company's flying personnel. Hofstede's Values Survey Module was administered for an evaluation of occupational culture. The analysis reveals group differences at the occupational level in the perception of power distribution, team orientation and achievement preferences. The results are further discussed in relation to the crewmembers' different task demands and areas of responsibility, and emphasis is put on organizational responsibility for enhancing safety and effectiveness in the service.

Author

Emergencies; Medical Personnel; Medical Services

19950023196 Army Medical Command (18th)., Unit 15281.; **USA MEDICAL EVACUATION: A TRAINING PRIORITY**

Urbauer, Craig L., Army Medical Command (18th)., USA; Granger, Mathew S., Army Medical Command (18th)., USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 2 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

Medical evacuation is a comprehensive process which includes selecting the patients to be evacuated, determining the means of evacuation, and providing enroute medical care and intervention. The military medical community continues to stress the fact that medical evacuation is a medical process, not a logistic one. The 'chain of medical responsibility' is an important principle, but it does not relieve the ground maneuver commander of responsibility for the treatment and evacuation of casualties from the battlefield. Medical treatment and evacuation is a sustainment function as critical to the ground commander's success as arming, fueling, fixing, or moving. If the chain of medical responsibility is to have the proper means to succeed on the battlefield, the ground maneuver commander must establish medical evacuation as a training priority equal to the other sustainment functions.

Author

Education; Evacuating (Transportation); Medical Services

19950023197 Vaerloese Air Base, Medical Squadron 590., Vaerloese, Denmark

FLYING AMBULANCES: THE APPROACH OF A SMALL AIR FORCE TO LONG DISTANCE AEROMEDICAL EVACUATION OF CRITICALLY INJURED PATIENTS

Nielsen, J. Nybo, Vaerloese Air Base, Denmark; Lyduch, S., Vaerloese Air Base, Denmark; Larsen, F. K., Vaerloese Air Base, Denmark; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 3 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The Danish Air Force has developed a system for Aeromedical Evacuation of injured soldiers, based on flying ambulances inside a C-130. The ambulances function as mobile intensive care units, and provide a quiet, well lit and air-conditioned environment for observation and treatment of the patients. The system has a limited capacity, but it has so far proved sufficient to support the Danish participation in the UN-peacekeeping missions in the former Yugoslavia. A number of missions have been successfully carried out, three of them with two ambulances in the C-130. The system has the added advantage of providing door to door transport, without the need for moving the patient from ambulance to aircraft, and again from the aircraft to another ambulance on arrival in Denmark. to increase the capacity in the future, a system using specially equipped containers to be carried in the cargo bay of a C-130 is under consideration, and 2 such containers will probably be ordered this year. For the future AIREVAC support of a Danish battalion as part of NATO's Rapid Reaction Forces, we suggest a system based on chartered Boeing 737's or similar aircraft, and reservist personnel which should be identified and trained for the mission. The readiness of the system should be insured through planning, including contracts with airlines and personnel, training of medical personnel and procurement of stretcher support system and medical supplies.

Author

Air Transportation; Ambulances; C-130 Aircraft; Evacuating (Transportation); Medical Equipment; Medical Services

19950023198 Department of the Air Force, Nurse Corps., Brooks AFB, TX, United States

CIVIL RESERVE AIR FLEET-AEROMEDICAL EVACUATION SHIPSET (CRAF-AESS)

Nistler, Candy Jean, Department of the Air Force, USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 2 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

In 1985, the USAF/SG, AMC/SG, and CINCAMC agreed in time of war there would not be enough C-141's and C-9's that could be dedicated to Aeromedical Evacuation (AE). It was decided to design a kit that could re-configure Civil Reserve Air Fleet aircraft, specifically the Boeing 767, into AE aircraft to perform strategic and CONUS missions. A formal acquisition program was planned and executed by the Human Systems Program Office, Brooks AFB, TX, to design, develop, and produce the conversion kit for the Boeing 767. Developmental and Operational Test Evaluation Flights were flown in March 1991. The FAA issued flying certificates for two configurations of the Boeing 767 conversion kit; one to carry 111 litter patients and one to carry 87 litter patients. The CRAF-AESS has three subsystems. The Patient Transport Subsystem (PTS) consists of the litter stanchions and litter support arms for up to 111 litter patients. The Medical Oxygen Subsystem (MOS) consists of six 75 liter Dewars, which supply therapeutic oxygen outlets located at each potential litter position. The Aeromedical Operations Subsystem (AOS) consists of six 35 amp electrical converters to convert aircraft power to regular hospital current for medical equipment use. Electrical outlets are located at each potential litter position. This subsystem also includes two nurse workstations and seats. The airlines signed a contract with the USAF to be a CRAF-AESS supporter. Civilian airline pilots will fly the CRAF-AESS aircraft, airline flight attendants will be in charge of emergency egress, and the Systems Program Office is currently in full production for 44 shipsets. There are 17 complete shipsets delivered to date. CRAF-AESS will expand the USAF AE capabilities during war and allows medical personnel to provide excellent medical care.

Author

Air Transportation; Boeing 767 Aircraft; Evacuating (Transportation); Medical Equipment; Medical Services

19950023199 Army Aeromedical Research Lab., Aircrew Protection Div., Fort Rucker, AL, United States

FIRST MEDICAL TEST OF THE UH-60Q AND EQUIPMENT FOR USE IN US ARMY MEDEVAC HELICOPTERS

Bruckart, J. E., Army Aeromedical Research Lab., USA; Licina, J. R., Army Aeromedical Research Lab., USA; Quattlebaum, M. D., Army Aeromedical Research Lab., USA; AGARD, Recent Issues and

Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 5 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

The U.S. Army operates helicopters worldwide, including over 500 designated for medical evacuation (MEDEVAC). Advanced avionics and a commercial medical interior have been installed in a Black Hawk helicopter, designated the UH-60Q. MEDEVAC aircraft also carry commercial medical devices that can fail from stresses of in-flight use or interfere with critical rotary-wing aircraft systems. The U.S. Army Aeromedical Research Laboratory (USAARL) performed the first flight tests evaluating the medical interior in the UH-60Q and tested commercial medical devices to determine their compatibility with MEDEVAC aircraft. Flight tests in the UH-60Q validated the enhanced capability provided by the new avionics systems, external rescue hoist, oxygen generator, built-in suction, litter lifts, and improved crew seating. The new litter lift system provided inadequate vertical clearance and several components of the restraint hardware were not sufficiently durable. From January 1989 to January 1994, 40 medical devices, including monitor/defibrillators, infusion pumps, vital sign monitors, ventilators, oxygen generators, and infant transport incubators, were tested under extreme conditions of temperature, humidity, altitude, and vibration (MIL-STD 810). Electromagnetic emissions and susceptibility were measured (MIL-STD 461 & 462). Thirty-two percent of the medical devices failed at least one environmental test and 92 percent of the devices failed to meet electromagnetic interference standards. Eighteen percent of the commercial medical devices were judged unsuitable for use in the UH-60 MEDEVAC helicopter. Testing is critical to discover the ability of a new aircraft system or medical device to perform in the harsh rotary-wing MEDEVAC environment. Failure of a device or interference with aircraft systems can result in loss of a patient or aircrew.
Author

Evacuating (Transportation); Helicopters; Medical Equipment; Medical Services

19950023200 Army Aviation Brigade, Mendig, Germany
THE LARGE-CAPACITY RESCUE-HELICOPTER CH-53 G
Schroedl, Christoph, Army Aviation Brigade, Germany; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 3 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

A new concept has been developed: (1) for handling great numbers of casualties during disasters and events entailing major damage; (2) for providing quick support of medical treatment facilities employed by crisis reaction forces during out-of-area operations; and (3) for accomplishing medical evacuation and combat rescue missions. In view of current planning conducted by the German armed forces in conjunction with the crisis reaction forces this concept takes on an increased tactical significance in the context of studies concerning medical support of medical treatment facilities and also when it comes to missions related to combat rescue and medical evacuation. During several real-time operations and numerous exercises the 'large rescue helicopter CH- 53 G' concept has proved to be efficient.
Author

Air Transportation; Evacuating (Transportation); H-53 Helicopter; Medical Equipment; Medical Services; Rescue Operations

19950023201 Department of the Air Force, Armstrong Lab., Brooks AFB, TX, United States
INTERNATIONAL ACCESS TO AEROMEDICAL EVACUATION MEDICAL EQUIPMENT ASSESSMENT DATA
Hale, Jacqueline, Department of the Air Force, USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 3 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A02, Microfiche

Aeromedical evacuation medical equipment development using evaluation and often times modification by the manufacturer to achieve compatibility in the airborne environment began over 25 years ago at Brooks AFB in support of Military Airlift Commands (now Air Mobility Command) medical evacuation mission. This approach was adopted because sometimes standard research and development methods were not responsive to Command requirements. In the course of those years simple items such as securing devices to those as complicated as an Extracorporeal Membrane Oxygenation System have been extensively evaluated using a battery of tests to verify adapt ability to altitude and compatibility with aircraft systems. Because technology in aircraft systems and in medical equipment has advanced, so has the importance of testing for situational compatibility. Medical devices may produce electromagnetic interference with aircraft navigation or communication systems and aircraft systems can interfere with the operation of medical devices. Results of tests conducted at Armstrong Laboratory Brooks AFB are published as individual detailed Technical Reports and later compiled into a comprehensive document entitled 'Status Report on Medical Material Items Tested and Evaluated For Use In The USAF Aeromedical Evacuation System'. This publication was available for public release and met customer access needs of the day. However, with the advent of independent air ambulance services and increase in countries actively engaged in aeromedical evacuation, a need to better communicate results of testing emerged. Researchers at Armstrong Laboratory developed a database program for rapid dissemination of medical equipment airworthiness evaluation results and are exploring electronic delivery avenues to meet the need for worldwide accessibility.
Author

Air Transportation; Aircraft Reliability; Data Bases; Evacuating (Transportation); Medical Equipment; Medical Services

19950023207 USA Air Forces in Europe, APO New York, NY, United States
CHANGES IN THE MEDEVAC MISSION RESULT IN AN INCREASED ROLE FOR THE FLIGHT SURGEON
Lyons, T. J., USA Air Forces in Europe, USA; Connor, S. B., USA Air Forces in Europe, USA; AGARD, Recent Issues and Advances in Aeromedical Evacuation (MEDEVAC); Feb 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Historically physicians were involved in the development of aeromedical evacuation (medevac) and flight surgeons flew as crewmembers on the first US military medevac flights. However, since World War II flight surgeons have not been routinely assigned to operational medevac units. The aeromedical literature addressing the role of physicians in medevac is controversial. Recent contingencies involving the U.S. Air Force (USAF) have required the augmentation of medevac units with flight surgeons. Since 2 February I993, USAFE has moved 221 patients on 27 missions out of the former Yugoslavia -- most of these missions had a flight surgeon on the crew. Because advanced medical information on the status of these patients is often non-existent, the presence of a physician on the crew proved lifesaving in some instances. In peacetime operations, there has been a recent trend in the European theater for the USAF to move more unstable patients. Beginning in 1993, USAFE assigned three flight surgeons to the medevac squadron. Dedicated medevac flight surgeons have proven to have the specific experience and training to perform effectively in the role of in-flight medical attendant. Their understanding of the system also makes them more effective in medical validation than non-medevac flight surgeons. In addition, they are effective in negotiating with referring physicians about the urgency of movement, required equipment, the need for medical attendants, etc. These flight surgeons provide medical coverage of transiting patients in the Aeromedical Staging Flight (ASF), thus providing needed continuity in the medevac system. In conclusion, dedicated medevac flight surgeons fill a unique and valuable role. Recommend that agencies with medevac units consider assigning flight surgeons to these units.
Author

Air Transportation; Evacuating (Transportation); Flight Crews; Flight Surgeons; Medical Services; Warfare

19950026072 British Aerospace Aircraft Group, Warton Aerodrome., Preston, United Kingdom
OPTIMUM ROUTEING: ANALYTICAL CONSTRAINT OF SEARCH SPACE
Semple, W. G., British Aerospace Aircraft Group, UK; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Algorithms are being developed for route optimization using the geometric constraints imposed on route geometry by zero-gradient conditions on route costs. Two related techniques are under consideration. The first takes a spatial search approach using the geometric constraints to guide the search. The second uses the errors in the constraint equations on a given path to derive an iterative correction. The first technique itself divides into free, or path-aligned propagation, and bound, or grid-aligned propagation. The former enables removal

of many terms in the equations, the latter removes the need for complex geometric housekeeping. to date, the techniques have been coded for two-dimensional scalar isotropic cost functions. Work is in hand to progress this to non-isotropic and multi-dimensional cases, especially to cater for representative threat tracking and missile characteristics and for fuel consumption. Results from the code produced so far are extremely encouraging. The principles have been shown to be sound, and full spatial search achieved without combinatorial explosion of computing demand. Fine-grain searches of sizable grids have been completed in less than half a second on a workstation of modest performance. 'Real' cases will in general require dynamic cost density and derivative calculations. Conventional methods can deliver these at sufficient granularity and at a sufficient rate for the present search methods, given that there appears to be scope for the average granularity in the method to be coarsened considerably. For refinement of coarse-grained search output, a fast iterative scheme has been produced. Subsequent development will address extending its stable range of usability.
Derived from text
Algorithms; Coding; Combinatorial Analysis; Computer Programming; Computer Programs; Control Theory; Ray Tracing; Routes; Searching; Variational Principles

19950026073 GEC-Marconi Avionics Ltd., Rochester, United Kingdom
A TACTICAL NAVIGATION AND ROUTEING SYSTEM FOR LOW-LEVEL FLIGHT
Hewitt, C., GEC-Marconi Avionics Ltd., UK; Broatch, S. A., GEC-Marconi Avionics Ltd., UK; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Many types of offensive air operations need to be carried out at low level in order to ensure survivability and to maximize the probability of mission success. However, such a flight trajectory is workload intensive and leaves little room for pilot error. It would be highly beneficial if the activities of in-flight route planning, obstacle, threat and terrain avoidance, and time and fuel monitoring could be automated. This paper presents an integrated solution to this automation problem based on the effective exploitation of terrain and mission databases. The requirements of the component parts of this system are presented. These include: (1) an optimum routing algorithm, together with the criteria used in selecting the optimum four dimensional route for all mission scenarios; (2) a ground and obstacle collision avoidance system which enables the pilot to fly low, while providing timely warnings of imminent high terrain and obstacles; and (3) the navigation accuracy required to support the optimum routing and collision avoidance systems. The paper then describes a number of systems that have been developed by GEC-Marconi Avionics with the support of the Defence Research Agency (DRA), UK Ministry of Defence. The first is an optimum routing algorithm which uses terrain and mission databases to generate an optimum route, taking account of threats, terrain, obstacles, time and fuel constraints. A description of a predictive Ground and Obstacle Collision Avoidance Technique (GOCAT) is then presented. This uses a terrain and obstacle database to assess whether the current and future aircraft trajectory is safe. Finally the navigation requirements to support these systems are discussed and a solution based on integrated INS, GPS, Map Referenced Navigation (MRN) and Edge Detection Navigation (EDN) is described.
Derived from text
Air Navigation; Automatic Control; Collision Avoidance; Edge Detection; Flight Paths; Global Positioning System; Obstacle Avoidance; Tactics; Terrain Following; Trajectories

19950026075 Defence Research Agency, Farnborough, Hampshire, United Kingdom
THE APPLICATION OF HELICOPTER MISSION SIMULATION TO NAP-OF-THE-EARTH OPERATIONS
Birkett, P. R., Defence Research Agency, UK; Roden, D. W., Defence Research Agency, UK; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 5 p; In English; Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

This paper describes some of the system trade-offs and integration issues associated with the next generation of battlefield helicopters operating in the NOE environment. The interactions between weapons, sensors, aircrew and the platform itself are discussed and their influence on the effectiveness of the helicopter as a total system is considered. Finally, an approach to the study of helicopter system integration is presented. The 'multipleman-in-the-loop' mission simulator, HOVERS, is described and its application to a typical trade-off issue discussed.
Derived from text
Computerized Simulation; Flight Simulation; Helicopters; Human Factors Engineering; Man Machine Systems; Nap-Of-The-Earth Navigation; Systems Integration; Tradeoffs

19950026077 Alenia Aeronautica, System Technology Dept., Turin, Italy
AN INTEGRATED SYSTEM FOR AIR TO GROUND OPERATIONS
Avalle, Massimo, Alenia Aeronautica, Italy; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 10 p; In English; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The following paper describes, at the conceptual level, a possible solution for a system able to meet the hard requirements for attack A/Cs operating at low level into a high threat density scenario. The conceptual study related to this work takes place from a research program related to air to air engagements, as some concepts mainly related to pilot workload reduction can be tuned up air to ground missions. A research program to deeply analyze the more important functions related to the safe penetration concept could be initiated from this work. Some of the main concepts related to low level A/C operations are overview and possible enhancements related to the technology trend and to possible new functions derived from enhanced system integration are discussed as an introduction for the system description. The main functions forming the system will be described and an overview about the possible involved technologies will be supplied.
Author
Air Defense; Computer Systems Design; Ground Operational Support System; Head-Up Displays; Helmet Mounted Displays; Human Factors Engineering; Infrared Detectors; Man Machine Systems; Systems Integration; Terrain Following; Warning Systems

19950026084 Defence Research Agency, Man Machine Integration Dept., Farnborough, Hampshire, United Kingdom
COVERT NIGHT/DAY OPERATIONS FOR ROTORCRAFT (CONDOR) PROGRAMME
Southam, T. H., Defence Research Agency, UK; AGARD, Low-Level and Nap-of-the-Earth (NOE) Night Operations; Jan 1, 1995, 16 p; In English; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

CONDOR is a major joint US-UK project that will support a comprehensive demonstration of the functionality of current and future attack helicopters under day/night adverse weather conditions in a nap of the Earth environment. The aim of the program is to investigate the integration of a suite of avionics, sensors and displays for battlefield helicopters and to assess their effectiveness during ingress, egress and attack phases of the mission. The concept features a precision navigation system which together with a steerable sensor coupled visually, via a helmet-position sensing system, to an advanced helmet mounted display with a wide FOV, full colour and laser eye protection enables a virtual outside world overlaid with appropriate flight and mission information to the pilot. The program includes development and building of the advanced hardware, research into the human factors issues connected with their exploitation, symbology development coupled to a detailed application in a full mission scenario. Flight demonstrations are scheduled to take place in both the Lynx at DRA and, with subsequent testing in the U.S., to exploit a new full-authority FBW flight control system with mission configurable control laws.
Author
Attack Aircraft; Helmet Mounted Displays; Human Factors Engineering; Military Helicopters; Military Operations; Nap-Of-The-Earth Navigation; Radar Detection; Research Projects; Rotary Wing Aircraft; UK; USA

19960016903 Mitre Corp., Bedford, MA United States
OPERATIONAL EFFECTIVENESS THROUGH INTEROPERABILITY
Carney, J., Mitre Corp., USA; Corsetti, C., Mitre Corp., USA; Oct. 1995; 12p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The increasing use of joint service, coalition forces to support modern warfare continues to magnify the importance of superior and flexible tactical command, control, communications, and intelligence

(C3I) systems. Interoperability has become a commonly identified key component in the success of this modern warfare. In this context, interoperability can be defined as the capability for two or more C3I systems to share and manage common information to maximize the operational effectiveness of the combined force. Examples of common interoperability problems experienced during a number of military operations and exercises are described. Potential short and long term interoperability solutions, particulary in the areas of data communication, data fusion, and data management are presented.
Derived from text
Command and Control; Intelligence; Military Operations; System Effectiveness; Communication Networks; Management Systems; Operational Problems; Surveillance Radar; Warfare

19960016910 Naval Air Warfare Center, China Lake, CA United States
ADAPTIVE STRIKE PLANNING WITH SEARCH PATH ALLOCATION
Collins, R. E., Naval Air Warfare Center, USA; Alltop, W. O., Naval Air Warfare Center, USA; Goodson, D. W., Naval Air Warfare Center, USA; Reynolds, J. M., Naval Air Warfare Center, USA; Oct. 1995; 10p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Adaptive strike missiles have the capability to autonomously find and attack targets. In many cases, the location of the target is not known, and the missile must perform a search of the region in order to detect any existing targets. This search entails the planning of a search flight path, tailored to the sensor's capabilities, that will maximize the probability of detection. The Search Planner is composed of a search path subsystem that includes: (1) a tactical motion analyzer that takes into account terrain and feature data, and determines a probable search region based on the motion capability of the target; (2) a feature extractor subsystem which generates most-likelihood feature maps, such as tree-lines, that govern possible target locations within the critical region; (3) a path generator subsystem that determines the best search path by first covering the possible target locations with rectangular strips and then chaining them together in a near-optimal way; and (4) a sensor manager that optimizes allocation of sensor resources as the missile travels through the search region. to validate our concept, we have integrated the Search Planner into a many-on-many simulator that functions to optimally allocate a missile strike force en-route. This paper describes the design of the Search Path Planner subsystem which consists of a Search Area Generator, a Segment Generator, a Link Generator, and a Link Chainer module.
Derived from text
Missiles; Flight Paths; Adaptive Control; Decision Making; Artificial Intelligence; Target Recognition; Simulators; Air Defense; Radar Tracking; Change Detection

19960053042 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France
TECHNOLOGIES FOR PRECISION AIR STRIKE OPERATIONS IN RAPID-REACTION AND LOCALIZED-CONFLICT SCENARIOS *LES TECHNIQUES POUR LES OPERATIONS AIR-SOL DANS LES SITUATIONS DE CONFLITS LOCALISES ET DE REACTIONS RAPIDES*
Jun. 1996; 180p; In English; In French; 4th, 16-19 Oct. 1995, Seville, Spain; See also 19960053043 through 19960053058
Report No.(s): AGARD-CP-576; ISBN 92-836-0028-2; Copyright Waived; Avail: CASI; A09, Hardcopy; A02, Microfiche

This volume contains the Technical Evaluation Report and the 16 unclassified papers presented at the Mission Systems Panel Symposium held in Seville, Spain from 16-19 October 1995. Papers were presented covering the following headings: Operational Aspects; Mission Planning/Mission Management; Navigation; Reconnaissance and Target Identification; Targeting and Weapon Delivery Guidance.
Author
Conferences; Mission Planning; Weapons Delivery; Target Acquisition; Global Positioning System; Precision Guided Projectiles; Command and Control

19960053043 Supreme Headquarters Allied Powers Europe, Ops Log Div., Casteau, Belgium
THE NEED FOR PRECISION-GUIDED MUNITIONS IN LIMITED CONFLICT: AN OPERATIONAL VIEWPOINT
Hall, Ian, Supreme Headquarters Allied Powers Europe, Belgium; Jun. 1996; 6p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

A missed air-to-ground attack is never welcome by an operational commander; collateral damage and the increased possibility of attrition engendered by the necessary re-attack are but two of the likely, undesirable results. The effects may assume increased significance in a limited conflict, where political factors may bear relatively more heavily than in general war. Thus precision guided munitions (PGM) may be a highly desirable option. in the purely military sense, conditions prevailing on the less-dense battlefield may tend to present particularly favorable conditions for the employment of precision weapons; however, there may be counter arguments, and occasions where PGMs are not the best option. This paper offers examples from recent conflicts to support the general case for PGMs, before going on to discuss advantages and disadvantages of generic types of weapons. Finally, while acknowledging that nations are unlikely ever to procure weapons specifically for limited conflict, it discusses the ideal stockpile for small-scale operations. In doing so, it raises the point that characteristics of the target identification and designation system are likely to be at least as significant as those of the weapon itself.
Author
Military Operations; Ordnance; Target Recognition; Precision Guided Projectiles; Air to Surface Missiles; Politics; Warfare

19960053044 Eurocopter International, La Courneuve, France
HELICOPTER TASK FORCE: A MISSION EFFECTIVE SOLUTION FOR PRECISION AIR STRIKES
Mellies, D., Eurocopter International, France; Jun. 1996; 14p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Technologies introduced into the military helicopter which represent a rapid reaction potential are described. These include: air mobility including the capability of operating without airfield infrastructures, night vision for around the clock operations, fire power based on the integration of aircraft and weapons with system architecture. When combined with helicopter borne command, control and communications and intelligence (C3I) these technologies constitute an air mobile task force able to conduct airstrikes. This paper introduces the principles and techniques of air mobile operations, then applies these considerations to a realistic scenario, and fully details the technologies used to achieve the required precision.
Derived from text
Command and Control; Intelligence; Military Helicopters; Night Vision; Airborne Equipment; Military Operations; Target Recognition; Precision Guided Projectiles; Military Technology

19960053045 Naval Air Warfare Center, Strike Analysis Branch, China Lake, CA United States
PRECISION IMAGING STRIKE TECHNOLOGY INTEGRATION LABORATORY (PISTIL)
Reese, Thomas F., Naval Air Warfare Center, USA; Going, Ronald, Naval Air Warfare Center, USA; Jun. 1996; 4p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Precision guided weapons that employ advanced imaging infrared seekers, data links, and mission computers require detailed mission planning and rehearsal systems to ensure mission success. The cost to develop these weapons and mission planning systems are rapidly increasing as advanced signal processing algorithms are employed to increase the probability of target detection, acquisition and recognition, with the ultimate goal of accurate target tracking and precise aimpoint selection for maximum probability of kill and minimum collateral damage. This paper presents a real-time Precision Imaging

Strike technology Integration Laboratory (PISTIL) which provides precision guided weapons developers with many of the tools and data to answer key questions.
CISTI
Target Acquisition; Tracking (Position); Real Time Operation; Imaging Techniques; Data Links; Homing Devices; Infrared Radiation; Precision Guided Projectiles; Signal Processing; Mission Planning

19960053049 Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan, Italy
FRIEND IDENTIFICATION BY IR PICTURES ON HELMET MOUNTED DISPLAYS
Balzarotti, G., Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; Fiori, L., Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; Midollini, B., Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Italy; Technologies for Precision Air Strike Operations in Rapid-Reaction and Localized-Conflict Scenarios; Jun. 1996; 12p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

This paper outlines and analysis those aspects of visual identification of known objects as they are seen by a thermal imager and displayed on the visor of a helmet. The problem of magnification as well as the reduction of contrast due to the ambient light are evaluated and an analysis of the performance prediction is carried out.
Derived from text
Helmet Mounted Displays; Performance Prediction; Visors; Imaging Techniques; Head-Up Displays; IFF Systems (Identification); Temperature Effects

19960053050 British Aerospace Public Ltd. Co., Sowerby Research Centre, Filton, United Kingdom
TARGETING FOR FUTURE WEAPON SYSTEMS
Collins, P. R. C., British Aerospace Public Ltd. Co., UK; Greenway, P., British Aerospace Public Ltd. Co., UK; Edmondson, D. R., British Aerospace Systems and Equipment Ltd., UK; Green, M. A., British Aerospace Systems and Equipment Ltd., UK; Jun. 1996; 10p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

In future weapon systems, accurate target selection and location is required to maximize warhead effectiveness and minimize collateral damage. To help achieve this there should be available significant information about the target location from a variety of sources, e.g., satellite imagery, surveillance data and intelligence information. On board the vehicle there will normally be a navigation system which has a good estimate of its position and often there will be an electro-optical (E-O) sensor which produces imagery of the terrain ahead and the target. There is also available an increasing level of computational power and software techniques including fast image processing systems. Using a model from a prepared database of terrain features matched to features extracted from such an image, it is possible to estimate the sensor position and hence the target position. We discuss here a 'proof of principle' system which demonstrates a robust mechanism for achieving this. We describe an implementation using data gathered from a camera moving across a terrain model and results are presented.
Author
Image Processing; Position (Location); Satellite Imagery; Computerized Simulation; Target Acquisition; Global Positioning System; Weapon Systems; Remote Sensing; Video Compression; Damage Assessment

19960053051 Naval Air Warfare Center, Weapons Div., China Lake, CA United States
DIGITAL VIDEO COMPRESSION FOR WEAPONS CONTROL AND BOMB DAMAGE INDICATION
Creusere, Charles D., Naval Air Warfare Center, USA; Hewer, Gary, Naval Air Warfare Center, USA; Jun. 1996; 10p; In English; See also 19960053042; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The goal of this paper is to familiarize the reader with the major image and video compression technologies in the context of weapons control (WC) and bomb damage indication (BDI) applications. Towards this goal, we discuss the operation and limitations of the four major still image compression techniques: discrete cosine transform (DCT), wavelet transfor, vector quantization, and fractual. We then consider the broader problem of implementing video compression algorithms which use the previously discussed still image compression algorithms as basic building blocks. Some of the techniques examined here are motion estimation, motion compensation for prediction and interpolation, and 3-dimensional subband coding. Finally, we discuss the major characteristics of digital video compression and transmission systems, concentrating on the impact they have on WC and BDI system performance. Many of these characteristics are desirable in every compression application (e.g. good image quality) but some of them are especially important for low-cost remote-sensing platforms (e.g., a low-complexity video encoder). In addition, some characteristics like video latency are important for the weapons control application but not for the BDI application. Within this framework, we discuss the various images and video compression technologies available and highlight those which are particularly good or bad for WC/BDI applications.
Author
Video Compression; Military Technology; Global Positioning System; Digital Television; Homing Devices; Targets; Coders

19960053054 Societe d'Applications Generales d'Electricite et de Mecanique, Div. Navigation et Defense, Paris, France
COMBINATION OF NEW GENERATION OPTRONIC SENSORS FOR NAVIGATION AND ATTACK SYSTEMS *ASSOCIATION DE CAPTEURS OPTRONIQUES DE NOUVELLE GENERATION AUX SYSTEMES DE NAVIGATION ET D'ATTAQUE*
Joffre, J., Societe d'Applications Generales d'Electricite et de Mecanique, France; Jullien, E., Societe d'Applications Generales d'Electricite et de Mecanique, France; Bernoville, J. P., Societe d'Applications Generales d'Electricite et de Mecanique, France; Goulette, R., Societe d'Applications Generales d'Electricite et de Mecanique, France; LeGuilloux, Y., Societe d'Applications Generales d'Electricite et de Mecanique, France; Jun. 1996; 10p; In French; See also 19960053042; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Infrared sensors have been integrated on military aircraft for over 20 years. Among them, are forward-looking infrared sensors (FLIR), generally installed in the navigation pod. These are dedicated to night flying and designation pods, used in the terminal phase of air to ground attack. While the need for night time navigation exists in order to ensure around the clock air treats, it has been determined that the generalization of infrared system has not been implemented in military aircraft. Technological evolution has recently led to the use of high performance sensors, which take up a reduced amount of space, and therefore can be integrated into the airframe, and are capable of fulfilling two basic mission functions: navigation and attack. The appearance of new generation optronic imagery which uses infrared charge coupled device (IRCCD) detectors therefore allow for important advances in air to ground strike missions. The purpose of this article is to specify principles and characteristics of the IRCCD sensors used in France, and their contribution during a night mission. to do this,the following studies carried out by SAGEM with the support of the State Services Branch are described: the IRIS thermal camera, integration achieved on the Mirage 2000 aircraft, night piloting systems, navigation recomputation methods using infrared imagery, and contribution pertaining to air-to-ground night attacks.
Author
Charge Coupled Devices; FLIR Detectors; Infrared Radiation; Pods (External Stores); Image Processing; Night Flights (Aircraft)

19970000628 Armstrong Lab., Aircrew Training Research Div., Mesa, AZ United States
ESTIMATING THE TRAINING EFFECTIVENESS OF INTERACTIVE AIR COMBAT SIMULATION
Wang, Wayne L., Armstrong Lab., USA; Bell, Herbert H., Armstrong Lab., USA; Apr. 1996; 12p; In English; See also 19970000594; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper is concerned with the general problem of measuring the value of simulation for combat mission training. There are a number of engineering efforts currently attempting to develop multi-player, virtual simulations that will allow soldiers, sailors, and pilots to interact with one another in a synthetic battlefield for combat mission training. This paper will briefly discuss the continuation training environment that simulation must effectively complement and the various approaches for obtaining training effectiveness data for estimating the training payoff of these efforts. It will then summarize the results of recent efforts conducted by the Armstrong Laboratory to assess the

value of combat mission simulation for continuation training of pilots. Although the results of these studies indicate high user acceptance for simulation and improved performance during the course of simulator-based training, transfer of training data has yet to be obtained.
Author
Flight Simulation; Transfer of Training; Training Simulators; Military Operations; Military Technology

19970018629 Air Force Logistics Command, Range Squadron, Hill AFB, UT United States
OPERATIONALLY REPRESENTATIVE TESTING OF MODERN TACTICAL WEAPONS
Bergevin, Dean H., Air Force Logistics Command, USA; Subsystem Integration for Tactical Missiles (SITM) and Design and Operation of Unmanned Air Vehicles (DOUAV); Nov. 1996; 11p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Increased weapon sophistication, interaction between different weapon capabilities, and increased weapon cost have led to increased reliance on large scale multiple objective test and training exercises. This combination can simultaneously obtain high value training and weapons test data with minimum expenditure of weapon assets. This paper details the experience of Utah Test and Training Range (UTTR) in supporting increasingly sophisticated weapons test and training programs conducted by the U. S. Air Force. Objectives, procedures, and test equipment used by such Air Force Air Combat Command programs as the Weapon Systems Evaluation Program (WSEP) and Conventional Air Launched Cruise Missile are discussed. WSEP tests multiple precision guided munition types, including the sophisticated High Speed Anti-Radiation Missile (HARM), Maverick, and Have Nap missiles. All tests are conducted using aircraft and aircrews from operational units in a realistic 'war game' environment against realistic targets to provide unmatched training for multiple fighter and bomber squadrons. Fiscal year 1994 WSEP tests involved nine fighter units and over 150 weapons at UTTR. Strategic and tactical cruise missile tests are also conducted using operational aircraft, crews, and equipment flying long range routes simulating wartime requirements. Simulated missile launch areas add operational realism. Missile profiles are designed to exercise missile launch, enroute guidance, and terminal attack capabilities. Weapons data are collected and used to evaluate accuracy, effectiveness, and reliability. Methods, procedures, and test range equipment used by UTTR to support tactical missile tests are discussed. Constraints necessary to meet range safety requirements are discussed, as well as methods used to minimize the constraints.
Author
Weapon Systems; Cruise Missiles; Missile Tests; Test Ranges; Test Equipment; Procedures

19970018636 Georgia Tech Research Inst., Atlanta, GA United States
THE FUTURE FOR UAVS IN NATO
Michelson, Robert C., Georgia Tech Research Inst., USA; Nov. 1996; 5p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The face of NATO is changing in the light of the demise of the Soviet Block, however the need for NATO is perhaps more critical today than ever before due to the fragmented warring factions that have arisen in the absence of the stabilizing oppression of the Soviet Union and the Warsaw Pact. Unfortunately, these changes are occurring in the face of a global recession that has prompted the Nations to reconsider past levels of military spending. The demise of the Soviet Union is viewed as a reason to draw down forces and rely on existing (and sometimes antiquated) defense infrastructures. Advances in machine intelligence and robotics can be leveraged to offset the negative impact of economically-induced factors affecting the Nations' forces during the next decade. Particularly in the areas of reconnaissance, intelligence, early warning, and even certain lethal operations, the use of Unmanned Aerial Vehicles (UAV) is predicted to be a major factor in the maintenance of an affordable military presence. Law intensity conflicts along the borders of the Nations (as already witnessed in Bosnia) are expected to continue. Coupled with the need to continue certain NATO activities more effectively, is the occurrence of expanded missions that will arise due to increased trade in contraband as the Economic Community facilitates a more open Europe. Both land-based and maritime UAVs have a definite place within the NATO infrastructure, but currently the individual Nations do not have a clear or unified road map to define their use. Given a coordinated plan for the use of UAVs by the Nations, what critical technologies must be put in place over the next few years to allow UAVs to meet the challenges of the missions expected by the year 2000? How will the predicted burgeoning of the commercial market for UAVs by the year 2000 affect NATO interests in this technology, and how can NATO leverage this commercial market for its own benefit? This paper will identify both the military and commercial UAV missions expected by A.D. 2000. The analysis will consider the particular regional requirements posed by the geography of the member nations.
Derived from text
North Atlantic Treaty Organization (NATO); Artificial Intelligence; Military Operations; Pilotless Aircraft

19970018637 Austin (R. G.), Bracknell, United Kingdom
LESSONS LEARNED IN THE DEVELOPMENT AND OPERATION OF REMOTELY PILOTED HELICOPTERS
Austin, R. G., Austin (R. G.), UK; Nov. 1996; 14p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Lessons learned, both in development and operation, of rotary wing UAVs over a period of some 25 years are described. In particular it has been found that air vehicle compactness and vertical flight capability offers operational versatility not available to fixed-wing systems. There is no cost or reliability penalty to pay for this though design must take account of the dependence of the VTOL UAV on an accurate height sensor and the demands of scale (compared with manned systems) on the technology.
Derived from text
Design Analysis; Helicopters; Unmanned Spacecraft; Investigation

19970018639 Systemtechnik Nord G.m.b.H., Unmanned Aerial Vehicles, Bremen, Germany
TECHNOLOGY AND APPLICATION OF MODERN DRONE SYSTEMS
Baeker, J., Systemtechnik Nord G.m.b.H., Germany; Moehring, M., Systemtechnik Nord G.m.b.H., Germany; Schlenkrich, V., Systemtechnik Nord G.m.b.H., Germany; Nov. 1996; 4p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

Modern drones represent robotic systems which pick up situations in their environment by sensor payloads, assess them by preprogrammed mission logic and react according to their predefined mission. Some functions of the air vehicle may be controlled or supervised interactively by operators from a ground control station. Typical tasks for drone systems are: reconnaissance; surveillance; target localization; electronic warfare; target combat in adverse environmental conditions, e.g. considerable threat by enemy air defence systems (ADS). The different tasks lead to two major designs for the air vehicle: the reusable drone, e.g. for recce missions and the expendable / fire and forget drone, e.g. for combat missions. These design criteria determine the range of the necessary ground equipment, e.g. for drone refurbishing, number of staff as well as the training effort. Due to the threat by ADS, the drones should have low signatures in the frequency bands of visual, infrared, acoustic and radar sensors to minimize the probability of being detected and jammed or shot down.
Derived from text
Drone Vehicles; Surveillance; Electronic Warfare; Targets; Reusable Spacecraft; Design Analysis

19970018644 METEOR Costruzioni Aeronautiche ed Elettroniche S.p.A., Finmeccanica IRI Group, Ronchi dei Legionari, Italy
MULTIPLE UMA'S IN-FLIGHT MANAGEMENT
Siardi, Carlo, METEOR Costruzioni Aeronautiche ed Elettroniche S.p.A., Italy; Nov. 1996; 14p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Up to now significant effort has been posed in exploiting the basic UMA functionalities and operational growth potentials: almost all issues concerning single UMA employment are currently being addressed and solutions are due to come. Instead, Multiple UMA's control and operational Management (MUM) is still an open issue which has to pass through accurate and comprehensive operational scenarios evaluation and thus ending up with proper requirement definition. The present paper deals with this latter statement, also trying to outline potential problems which may arise operationally. Among the many parameters involved, timing is going to be the key parameter to

handle, in order to allow full UMA utilization within multi-forces operations. As far as multiple UMA's controlled by a single GCS are concerned, this issue can be translated in how accurately the time windows tied to each navigational waypoint are intercepted by the in-flight air-vehicles. Therefore the question moves to which parameter must be controlled by the UMA Flight Management System and how is it influenced by the en-route wind. Another intriguing subject is closely connected to the link band employed: provided satellite links represent a viable and effective solution, we hereon limit are discussion to conventional ground links. In case of NATO standard J-Band link a narrow beam is necessary due to the band typical fading margin and energy losses. Since a GCS has to cope with several UMA's performing their missions, an accurate trade-off must be conducted to establish a proper balance between several basic parametric constraints, such as ground antenna beam width, spatial air-vehicle navigational accuracy, Ground Data Terminal antenna stabilization, GCS Man Machine Interface and so on, in order to guarantee a reliable air-vehicle acquisition for proper tracking and data gaining. Moreover, link loss and failures management during silent flight are going to be tough subjects to cope with, for they represent potential hazards within airspace control activities. Last but not least is how to demonstrate the fullfillment of the requirements, keeping an eye on testing costs and risk reduction.
Author
Antenna Radiation Patterns; Communication Satellites; Data Links; Flight Control; Flight Management Systems; Man Machine Systems; Superhigh Frequencies

19970018645 Instituto Superior Tecnico, Lisbon, Portugal
ARMOR PROJECT: AUTONOMOUS FLIGHT CAPABILITY
Lourtie, P., Instituto Superior Tecnico, Portugal; Azinheira, J. R., Instituto Superior Tecnico, Portugal; Rente, J. P., Instituto Superior Tecnico, Portugal; Felicio, P., Instituto Politecnico de Setubal, Portugal; Nov. 1996; 12p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Unmanned Aerial Vehicles have a definite potential for civilian observation and reconnaissance missions such as forest fire detection or coastal waters surveillance. For a decision to use such vehicles in significant numbers to be taken, once the adequate legal framework is defined, they must be easy to operate at a low cost. The ARMOR project aims at developing such a vehicle. The ease of operation requires that the vehicle is sufficiently autonomous to perform most of the mission without the contribution of an experienced pilot. To achieve this degree of autonomy it must have a reliable Vehicle Management System (VMS) capable of dealing with both normal and anomalous situations. A structure for the VMS is presented and the work being done in fault detection is presented. The vehicle will have to be extensively tested, increasing progressively its complexity, starting with a simple guidance system and finishing with the full VMS. This means that the guidance system is one of the first to be developed. The work being done for this system is also presented. The guidance system has to be highly reliable but simple for low cost. For the types of operation envisaged, precision is not a very stringent requirement. As a whole, simplicity induces lower costs but also lower precision. One of the objectives of the work being done is to define the minimum amount of information on the flight path compatible with guidance system efficiency. Some of the results obtained so far are shown and discussed.
Author
Autonomy; Pilotless Aircraft; Cost Reduction

19970018649 Thomson-CSF, Div. Systemes Missiles, Bagneux, France
AUTOMATIC ALERTING SYSTEM TO COUNTER LOW AND VERY LOW ALTITUDE ANTISHIP MISSILES *SYSTEME D'ALERTE AUTONOME DEPORTE CONTRE MISSILES ANTINA VIRES BASSE ET TRES BASSE ALTITUDE*
Fesland, S., Thomson-CSF, France; Nigron, P., Thomson-CSF, France; Subsystem Integration for Tactical Missiles (SITM) and Design and Operation of Unmanned Air Vehicles (DOUAV); Nov. 1996; 12p; In French; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The system for alerting naval personnel in the defense of surface vessels against low and very low missiles is described. It is supported by the original concept of premature warning using automatic unmanned aerial vehicles (UAV). A command logic for each UAV which accounts for different constraints (no collision with other UAVs, displacement of the surface vessels) is presented. It uses the theory of fuzzy logic. An informative simulation accomplished by THOMPSON-CSF permits obtaining results which prove the concept to be very promising. The results and various proposals are presented.
Transl. by SCITRAN
Pilotless Aircraft; Antiship Missiles; Systems Engineering; Early Warning Systems; Low Altitude

19970018650 GEC-Marconi Avionics Ltd., Flight Systems Group, Rochester, United Kingdom
THE PHOENIX TARGET ACQUISITION AND SURVEILLANCE SYSTEM
Dennis, R. W., GEC-Marconi Avionics Ltd., UK; Nov. 1996; 8p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Phoenix is the British Army's Battlefield Surveillance and Target Acquisition System in support of medium range artillery including MRLS. Unmanned Air Vehicles carrying Thermal Imaging sensors are controlled from a Ground Control Station (GCS) via a data link. This data link also sends real time thermal imagery to the GCS for analysis and fall of shot adjustment. Surveillance reports, target marks and fall-of-shot adjustments can be sent to the Fire Distribution Centre or direct to gun batteries via the Battlefield Artillery Target Engagement System (BATES). This paper briefly describes the system, outlines a typical mission, covers the integration, testing and evaluation of the system.
Author
Target Acquisition; Surveillance; Ground Based Control; Remotely Piloted Vehicles; Data Links; Thermal Mapping; Aerial Reconnaissance; Real Time Operation

19970018651 Societe d'Applications Generales d'Electricite et de Mecanique, Paris, France
CRECERELLE: A NEW GENERATION SYSTEM OF QUICK REMOTE CONTROL FOR RECONNAISSANCE, SURVEILLANCE AND ACQUISITION OF OBJECTIVES *CRECERELLE: UN SYSTEME D'AVION LEGER TELEPILOTE DE NOUVELLE GENERATION, POUR DES MISSIONS DE RECONNAISSANCE, DE SURVEILLANCE ET D'ACQUISITION D'OBJECTIFS*
Thin, G., Societe d'Applications Generales d'Electricite et de Mecanique, France; Durieux, P., Societe d'Applications Generales d'Electricite et de Mecanique, France; Subsystem Integration for Tactical Missiles (SITM) and Design and Operation of Unmanned Air Vehicles (DOUAV); Nov. 1996; 8p; In French; See also 19970018626; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The unmanned aerial vehicle (UAV) system CRECERELLE for reconnaissance, surveillance, and acquisition of targets, conceived and developed by the SAGEM group is in operation with the 7th Artillery Regiment. In numerous aspects, the system departs from the characteristics of previous systems. This departure is the result of new operational exigencies and a new geopolitic context which leads to the development of a primary system of robot reconnaissance based on recent technologies. The CRECERELLE system has been conceived as being in first place as a method for collection and processing of schematic information composed of a central unit - the ground station-associated with the gathering and processing of information and dissemination to fields of conflict. This equipment, representative of the advanced technologies developed for CERCERELLE, is described in this article.
Transl. by SCITRAN
Pilotless Aircraft; Remote Control; Aerial Reconnaissance; Target Acquisition; Surveillance; Robots

19970018652 General Atomics Co., San Diego, CA United States
PREDATOR: MEDIUM ALTITUDE ENDURANCE
Ernst, Larry, General Atomics Co., USA; Nov. 1996; 14p; In English; See also 19970018626; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The design, development and performance of a state-of-the-art UAV and ground control station is presented. Technological areas discussed include: The endurance, performance, and multi-frequency data link of Tier-1 Tactical Endurance UAV; payload, SAR all-weather capability, satellite control, and GPS & INS of TIER-2 Medium Altitude

Endurance UAV; performance, payload, and line-of-sight data link and autonomous flight of Joint Tactical UAV maneuver variant; and State-of-the-art common ground control station.
CASI
Pilotless Aircraft; Aircraft Design; Remotely Piloted Vehicles; Ground Based Control; Aircraft Performance

19970025428 Defence Research Agency, Systems Integration Dept., Farnborough, United Kingdom
THE APPLICATION OF HELICOPTER MISSION SIMULATION TO SYSTEM TRADE-OFF ISSUES
Tatlock, N., Defence Research Agency, UK; Silvester, C., Defence Research Agency, UK; Birkett, P., Defence Research Agency, UK; Apr. 1997; 4p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A01, Hardcopy; A04, Microfiche

This paper discusses the use of simulation for understanding some of the system trade-offs and integration issues associated with the next generation of battlefield helicopters. The HOVERS helicopter mission simulator at DRA Farnborough is discussed and examples of the types of benefits provided by its use are described.
Author
Helicopter Design; Fighter Aircraft; Tradeoffs

19970025433 Institute for Aerospace Research, Flight Research Lab., Ottawa, Ontario Canada
HELICOPTERS AND NIGHT VISION GOGGLES: A SYNOPSIS OF CURRENT RESEARCH ON HELICOPTER HANDLING QUALITIES DURING FLIGHT IN DEGRADED VISUAL ENVIRONMENTS
Baillie, Stewart W., Institute for Aerospace Research, Canada; Morgan, J. Murray, Institute for Aerospace Research, Canada; Apr. 1997; 10p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The role of the helicopter in military operations often involves flight in adverse weather conditions and the execution of flight maneuvers designed to maintain minimal exposure to the enemy. This translates into a requirement for helicopters to fly very low level, nap-of-the-earth, at night or in bad weather. This type of flying places a high demand on the pilot to accurately perceive the environment and to precisely control the flight path of the aircraft.
Derived from text
Goggles; Night Vision; Nap-Of-The-Earth Navigation; Military Operations; Helicopter Control; Flight Conditions; Controllability

19970029349 Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX United States
INFORMATION: THE WARFIGHTER'S EDGE. THE JOINT STRIKE FIGHTER (JSF) AND SYSTEM-OF-SYSTEMS (SOS)
Williams, Michael A., Lockheed Martin Tactical Aircraft Systems, USA; Collier, Larry G., Lockheed Martin Tactical Aircraft Systems, USA; Jul. 1997; 12p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Complete autonomous mission capability for tactical aircraft is no longer affordable nor necessary in view of the SoS concept. The JSF will rely upon national, theater, and tactical-level ISR to provide long-range target detection, location, and identification. Onboard systems will employ cues from the off-board collectors but will still be required to provide targeting and weapon employment capability as a result of latency and accuracy issues with ISR collectors. However, the resulting JSF on-board sensors will be much less complex in terms of power-aperture product, aperture complexity and/or system sensitivity: the current cost drivers in avionics. Total weapon system performance will be maintained through correlation and fusion of off-board information with onboard sensor data. In effect, off-board data, correlation, and fusion technology will enable a smaller and less complex on-board sensor system to perform like that of a much higher performance/cost system. Use of wingman data will allow on-board systems to be designed for less severe simultaneous mode capabilities. Lower cost, non-interferometer, apertures on multiple aircraft will be managed to provide highly accurate range and bearing data. The implementation of a SoS concept will enable an affordable JSF which can be procured in large enough numbers to replace end-of-life aircraft for the US and NATO allies.
Author
Aircraft Pilots; Avionics; Complex Systems; Cost Reduction; Weapon Systems; Target Acquisition

19970029351 Office of the Under Secretary of Defense (Acquisitions), Open Systems Joint Task Force, Washington, DC United States
DEPARTMENT OF DEFENSE PERSPECTIVE ON OPEN SYSTEMS ARCHITECTURE
Logan, Glen T., Office of the Under Secretary of Defense (Acquisitions), USA; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Due to down sizing of the U.S. defense budget, Department of Defense (DoD) does not have the resources to 'go it alone' anymore. This situation warrants closer cooperation among the DoD services, the industrial base and our allies. There is much to be gained from the wealth of technology available from the commercial sector, especially in electronics for telecommunications, computing, display, sensing and signal processing. For these reasons, among others, recent DoD policies have placed emphasis on performance specifications and standards as opposed to using military specifications and standards. The DoD open systems initiative supports this new emphasis and the five 'pillars' in transforming acquisition as delineated by the Honorable Paul Kaminski, Under Secretary of Defense for Acquisition and Technology: (1) Right Size Our Infrastructure (2) Reduce Cost of Weapon System Ownership (3) Implement Acquisition Reform (4) Leverage the National Industrial Base (5) Leverage Our Allies' Industrial Base The use of an open systems approach is motivated largely by the need (and the opportunity) to reduce the cost of ownership of weapons systems. Open systems are not the objective, rather an open systems approach is a means for program managers and their integrated product teams to achieve their fundamental program objectives of lower life cycle cost and improved performance. Open systems electronics applications include mechanical form factors, power supplies, radio/intermediate frequency (RF/IF) interfaces, and thermal management. An open systems approach uses widely accepted, public consensus standards, that any vendor can use as the basis for system design. Having already proven itself in commercial telecommunications and computing, an open systems approach has been used successfully by the military Command, Control, Communications, Computers and Intelligence (C4I) community and is now being implemented in the weapons systems acquisition community through the Open Systems Joint Task Force (OS-JTF). This paper will focus on the OS-JTF efforts to develop the foundations of open systems for weapon systems electronics.
Author
Architecture (Computers); Command and Control; Defense Program; Functional Design Specifications; Intermediate Frequencies; Systems Engineering; Telecommunication; Weapon Systems

19970029363 Naval Air Warfare Center, Weapons Div., China Lake, CA United States
RAPID TARGETING AND REAL-TIME RESPONSE: THE CRITICAL LINKS FOR EFFECTIVE USE OF COMBINED INTELLIGENCE PRODUCTS IN COMBAT OPERATIONS
Searle, Danny, Naval Air Warfare Center, USA; Kirchner, Rick, Naval Air Warfare Center, USA; Fincher, Ted, Naval Air Warfare Center, USA; Armogida, Frank, Naval Air Warfare Center, USA; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A variety of advanced technology projects have demonstrated the key components required to provide rapid targeting for a real-time response. Forward Hunter (led by NAWCWPNS) and Goldpan (led by the Air Force's Aeronautical Systems Center) are examples of Real-Time Information into the Cockpit/Offboard Targeting (RTIC/OT) demonstrations. These programs have shown the value of providing real-time mission updates (based on national offboard signals and imagery intelligence) to shooters pursuing time-critical targets. All these programs employed national exploitation systems and source material products to show that RTIC/OT can increase mission effectiveness, enhance survivability, and increase operational flexibility against time-critical fixed and mobile targets. Each demonstration has focused on different aspects of critical offboard targeting technologies, such as multisource national/theater intelligence fusion, rapid targeting, near-real-time mission replanning, data dissemination, and onboard processing.
AIAA
Onboard Data Processing; Real Time Operation; Intelligence; Imagery; Data Processing; Cockpits; Combat

19970029368 Sextant Avionique, Velizy-Villacoublay, France
DESIGN OF MISSION MANAGEMENT SYSTEMS: TECHNICAL AND METHODOLOGICAL APPROACHES ***CONCEPTION DES SYSTEMES DE GESTION DE MISSION: APPROCHES TECHNIQUE ET METHODOLOGIQUE***
Sassus, P., Sextant Avionique, France; Bonhoure, F., Sextant Avionique, France; Mariton, T. L., Sextant Avionique, France; Jul. 1997; 12p; In French; See also 19970029347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

On the strength of its competence in the field of traffic control and, more particularly, traffic management, especially regarding major programs involving combat aircraft, such as Mirage 2000 and Rafale, SEXTANT Avionique has for several years been interested in the development of missing management systems, permitting complete consideration of real time in the development of the operational context (tactical environment, weather, aircraft). For the purposes of defining suitable on-board operation, expert reports were received from operations personnel of the Air Force and the Navy; these made it possible to determine its role, field of use, its performance level (in terms of response time, etc.), of man-system interaction, and pertinent reconfiguration strategies.
Author
Air Traffic Control; Man Machine Systems; Real Time Operation

19970029369 National Aerospace Lab., Amsterdam, Netherlands
MISSION PLANNING SYSTEMS: CUBIC MULTIPLIERS
deMoel, R. P., National Aerospace Lab., Netherlands; Heerema, F. J., National Aerospace Lab., Netherlands; Jul. 1997; 8p; In English; See also 19970029347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A system that allows all the available and pertinent information to be used to plan a mission to achieve certain objectives in an optimum and near optimum way, and also data that describes the mission to be loaded into the aircraft. With respect to objectives, operating and technology mission planning systems can be considered as multipliers. This paper discusses some topics related to these multipliers. The National Aerospace Laboratory NLR, in The Netherlands, has a long time experience in development and production of military aircraft mission planning systems. In 1975 already NLR studied the feasibility of 'rear-port tube' graphic display systems for mission planning purposes. This type of display system provided the capability to project map information via a rear-port on the innerside of the display screen, so the screen itself could be applied to compose and show an overlay on the projected map. However, inadequate positioning accuracy of the overlay on the map with respect to navigation requirements made this rear-port tube graphics technology unfeasible for military aircraft mission planning systems. NLR's assessment of technology improvements is part of the section on technology. The most prominent multiplier is directly related to the mission objectives. Awareness of the actual battle theater and several types of advices (weapon - to - mission objectives suitability, minimum risk route, attack maneuvering etc.) are improving principally and practically the chances on mission success. Section 2 of this paper highlights two ingredients of this multiplier: - in the framework of interoperability the standardization of data exchange; in the framework of user friendliness a user definable electronic continuous map area. The second multiplier is the capability of mission planning systems to play a role in the training of military pilots with respect to the execution of real missions. To make this multiplier effective three conditions have to be fulfilled: - the mission planning system supports all mission types due to be exercised; - a metric system is available to assess the planned and sometimes also executed missions in detail; - fake realistic battle theaters are composed in such a way that progress in training can be determined. This second multiplier will be discussed in section 3. Mission planning systems are driving the technology: the third multiplier. Routing systems need always geographic/topographical/reconnaissance information and this information mass is e.g. driving storage capabilities, data compression techniques, and remote sensing derivatives. This subject will be discussed in section 4.
Author
Standardization; Routes; Remote Sensing; Reconnaissance; Pilot Training; Multipliers; International System of Units; Display Devices

19970036380 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
AEROSPACE 2020, VOLUME 2 ***AERONAUTIQUE ET ESPACE A L'HORIZON 2020, VOLUME 2***
Sep. 1997; 196p; In English; Original contains color illustrations
Report No.(s): AGARD-AR-360-Vol-2; ISBN 92-836-1058-X; Copyright Waived; Avail: CASI; A09, Hardcopy; A03, Microfiche

Volume 2, the main volume, of the report of the NATO Advisory Group for Aerospace Research and Development (AGARD) study: 'Aerospace 2020'. This study explored the most advanced technologies, relevant to aerospace, being researched and developed in laboratories today. The study focused on the most promising current technologies and the organizational and tactical consequences they will have at the field and system levels, over the course of the next 25 years. Topics include: a discussion of the impact of proliferation, human-machine interaction, synthetic environments, directed-energy weapons, information technologies, unmanned tactical aircraft, suborbital launchers, hypersonic missiles, and a discussion of affordability issues. Technologies are assessed from the viewpoints of both potential capabilities and threats. Observations and recommendations are presented.
Author
Aerospace Engineering; Forecasting; Weapon Systems; Hypersonics; Human Factors Engineering; Man Machine Systems; Pilotless Aircraft

19980016585 CAE Electronics G.m.b.H., Stolberg, Germany
ADVANCES IN FULL MISSION ENVIRONMENT SIMULATION TECHNOLOGY
Fuss, Norbert, CAE Electronics G.m.b.H., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 8p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

The significant advances in the field of simulation technology allow a more and more realistic reproduction of a weapon system's tactical environment. On the other hand, modem weapon systems place increasingly high demands on the quality and complexity of training equipment. In particular, such weapon system can no longer be regarded as autonomous, individual components. Rather, they have become an element of a complex military structure fulfilling operation-specific tasks. This leads to the conclusion that the design of training equipment should not only be system-specific but also operations-specific. The technologies which have been developed over the last years, especially in the fields of tactical simulation, computer-generated forces (CGFs) and networking, now enable the flexibility which is mandatory for structuring such a training system. The technological basis required for creating such a system will be discussed in this paper on the example of a Complex Air-Warfare Demonstrator, which has been developed under a European study contract.
Author
Military Operations; Weapon Systems; Warfare; Systems Simulation; Education; Computerized Simulation; Training Devices

19980016586 Cambridge Research Associates, McLean, VA United States
VIRTUAL ENVIRONMENTS: VISUALIZATION THROUGHOUT THE COMBAT MISSION
Adagio, Floyd, Cambridge Research Associates, USA; Babiak, Nicholas, Cambridge Research Associates, USA; Bollinger, Kenneth, Defense Micro-Electronic Activity, USA; Caposell, Charles, Naval Air Systems Command, USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 6p; In English; See also 19980016571; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

All levels of the military command structure, from senior military commanders to the forward combatant require visualization of data and fusion of tactical and strategic information. Specifically, visually oriented displays provide intuitive, readily understandable information that can be easily interpreted and acted upon. Visual systems provide a variety of data and information including maps, terrain elevation, imagery, iconics, symbology, and text. The effective use of military information in a combat situation should be specific to the individual mission, yet be consistent with all other levels of the military command structure. Consistency among and between command levels is critical to support coordinated planning, execution, and after-action activities.

This manuscript and associated presentation provide a discussion of the application of virtual visualization environments within a hierarchical requirements structure, based on warfighting functional requirements. Additionally, this presentation relates functional requirements to system characteristics and discusses utility of the information to airborne applications.
Author
Military Operations; Airborne Equipment; Multisensor Fusion; Imagery; Communication; Information Systems; Virtual Reality

19980018673 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
SOME THOUGHTS ON THE MILITARY MISSIONS AND OPERATIONAL SCENARIOS REGARDING HYPERSONIC VEHICLES ***QUELQUES REFLEXIONS SUR LES MISSIONS MILITAIRES ET LES SCENARIOS OPERATIONNELS RELATIFS AUX VEHICULES HYPERSONIQUES***
Cazin, Ph., Office National d'Etudes et de Recherches Aerospatiales, France; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 3; 12p; Summary translated by Schreiber; In French; See also 19980018672; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The article looks into powered flight in the atmosphere at hypersonic speed for certain military uses, such as: (1) long-range ground or surface attack missiles, where high speed improves the defense penetration capacities; (2) reconnaissance and surveillance drones; (3) very fast air-to-air missiles, capable of intercepting either ballistic missiles during the accelerated phase or airborne targets of great value at long range; (4) long-range ground or surface/air defense systems; and (5) faster and more flexible access to space, particularly during times of crisis.
Author
Hypersonic Vehicles; Military Operations; Reconnaissance; Surveillance; Air to Air Missiles; Ballistic Missiles; Drone Vehicles; Air Defense; Hypersonic Speed

19980033518 Wright Lab., Wright-Patterson AFB, OH United States
TRENDS IN FUTURE COMBAT AIRCRAFT DEVELOPMENT
Davis, R. W., Wright Lab., USA; Selegan, D. R., Wright Lab., USA; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 16p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The USA Air Force is currently going through a planning process to structure itself for the 21st Century. There have been several studies on this subject such as "Joint Vision 2010" that discuss mission requirements and the Air Force Scientific Advisory Board's "New World Vistas" that discuss relevant technology issues for the future. Figure 1 shows the six core competencies that the Air Force will maintain into the 21st Century. These core competencies will focus the Air Force mission areas and shorten the lines of communication between the user and the acquisition/research community through a new concept for the Air Force called Battle Labs. Purpose of the Battle Labs is to provide for the rapid assessment of technology on operational requirements under realistic conditions. This paper provides an update to these initiatives and provides the reader with an overview of the current Air Force Modernization Planning Process (AFMPP) and how it is effecting the Air Force Science and Technology Plans into the next millennium. This paper highlights several technology thrusts that will have an impact on air operations in the next Century.
Derived from text
Trends; Aircraft Design; Fighter Aircraft; Research and Development; Mission Planning

19980033519 Daimler-Benz Aerospace A.G., Military Aircraft Div., Munich, Germany
FUTURE COMBAT AIRCRAFT DEVELOPMENT IN EUROPE
Bridel, G., Daimler-Benz Aerospace A.G., Germany; Ross, H. G., Daimler-Benz Aerospace A.G., Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 12p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Within the last decade three new combat aircraft have been developed in parallel in Europe: The Eurofighter, the Rafale and the Gripen. This happened probably for the last time. New scenarios and missions, but in particular reduced defence budgets, the growing integration into a European Union and strong competition on the European and world market, in particular from the US and Russia, will eventually force (1) European nations to formulate common requirements; (2) the national Governments to coordinate their research and development efforts; (3) the airforces to coordinate their training, operation and maintenance activities; and (4) the national industries to form a common European military aircraft company, if a truly competitive military aircraft development and production capability in Europe is to be maintained.
Author
Aircraft Design; Fighter Aircraft; Research and Development; JAS-39 Aircraft

19980033521 National Defence Headquarters, Project Management Office, Armed Forces Utility Tactical Transport Helicopter, Ottawa, Ontario Canada
COST BENEFITS IN THE ACQUISITION OF A UTILITY TACTICAL TRANSPORT HELICOPTER FLEET FOR THE CANADIAN FORCES
Caux, L. A., National Defence Headquarters, Canada; Delaney, R. G., National Defence Headquarters, Canada; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 10p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The requirement for a Utility Tactical Transport Helicopter (UTTH) fleet is derived from the roles of the Canadian Forces and the specific missions assigned to the Land and Air Forces. In general, UTTH resources can be called upon to conduct operations in any of the following general mission areas: (a) Operational and training support to the land forces and other CF organizations; (b) International peacekeeping operations; and (c) Operations in aid of the civil authority.
Derived from text
Helicopters; Military Operations; Military Aircraft; Costs

19980210682 North Atlantic Treaty Organization, Consultation, Command and Control Agency, The Hague, Netherlands
NATO ALLIANCE GROUND SURVEILLANCE INTEROPERABILITY
Lenk, Peter J., North Atlantic Treaty Organization, Netherlands; Retzer, Gert, North Atlantic Treaty Organization, Netherlands; Apr. 1998; 8p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Through the NATO Alliance Ground Surveillance (AGS) Project, NATO is proposing to procure an airborne ground surveillance system based on a NATO-owned and operated core capability which would be supplemented by interoperable national assets, as required. The NATO Consultation, Command and Control (C3) Agency (NC3A), together with support from six nations, France, Germany, Italy, Norway, The UK and The USA, has established a testbed capability which includes simulations of the candidate sensor systems and various exploitation capabilities. This testbed, coupled with various other command and control testbeds resident at NC3A, allows the study of many aspects of command and control associated with the AGS problem. Essential to the selected ownership option is the concept of the interoperability of the NATO-owned assets with each other and with the nationally-owned assets. In order to address this problem, the NC3A, in conjunction with the six nations has developed an architecture and a standard format for the sensor data, so that any ground station could be made to receive and process data from any of the candidate platforms. Important to the solution is the ability to simultaneously receive and process data from different sensors and sensor platforms allowing for the fusion of data and potentially leading to improved surveillance coverage, tracking performance and accuracy. This approach has been prototyped and tested in the laboratory utilizing the AGS testbed. Recently, a large experiment was conducted during which several real AGS platforms and ground stations were utilized in order to prove the interoperability concepts that have been developed at NC3A in a more practical environment. In order to set the stage, the paper begins with a brief overview of the NATO AGS project followed by a definition of the interoperability problem. Next, the hardware and data architecture developed at NC3A for achieving interoperability is described. Finally, the paper concludes with a description of a recent AGS interoperability experiment used to prove the concepts is presented.
Author
Aerial Reconnaissance; Command and Control; Data Processing

19990007838 Alenia Spazio S.p.A., Product Development, Turin, Italy
FROM MANNED TO UNMANNED: A VIABLE ALTERNATIVE TO THE SCRAPYARD
Gatti, A., Alenia Spazio S.p.A., Italy; System Design Considerations for Unmanned Tactical Aircraft (UTA); Jul. 1998; 10p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Analyzing the different scenarios currently considered by NATO (Peace keeping, Out of Area, Counter Proliferation, Article 5) requirements of weapon systems at the same time precise, lethal, with a great stand-off range and endurance capability emerge. Budget, humanitarian and political needs together with improvements in technology suggest that un-habitated systems will become the best answer to those requirements. The Italian Air Force still operate a large number of F-104s that within a few years will be phased out. The conversion of F-104s into autonomous and recoverable unmanned vehicles able to perform ground attack or SEAD missions, or into a high-altitude reconaissance platform is feasible and seems an attractive and affordable way to develop an effective hardware able to safely operate in mixed air operations in which manned and unmanned planes share different roles.
Author
North Atlantic Treaty Organization (NATO); Pilotless Aircraft; F-104 Aircraft; Cost Effectiveness

19990007839 Aerospatiale, Defense Systems Preliminary Design Dept., Les Mureaux, France
THE ROLE OF UNMANNED TACTICAL AIRCRAFT IN THE BATTLEFIELD SURVEILLANCE
Thevenot, Regis, Aerospatiale, France; dAudiffret, Antoine, Aerospatiale, France; Jul. 1998; 8p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper deals with the role of Unmanned Tactical Aircraft (UTA) in tactical surveillance and support missions on a battlefield. It addresses the main following points: (1) A definition of what are the "UTA" addressed in this paper; (2) An overview of the new battlefields and their influence in the surveillance and reconnaissance missions and architectures; (3) A presentation of the environment where the UTA have to fly - atmospheric constraints, operational constraints, enemy constraints; (4) A description of the various missions which could be performed. In particular, for reconnaissance and surveillance missions, some examples extracted from STANAG 3769 will be given and will demonstrate the ability of some classes of UTAs and sensors to perform some specific missions; and (5) An overview of some UTA proposed by Aerospatiale and some other companies with their main characteristics. This part will be focused on existing systems such as CL 289 (deployed in Bosnia), Medium Altitude vehicles and High Altitude Long Endurance concepts. The paper will end with the description of some Concepts of Operations for UTA systems on a Battlefield.
Author
Pilotless Aircraft; Surveillance; Aerial Reconnaissance

19990007841 Defence Evaluation Research Agency, Centre for Defence Analysis, Farnborough, United Kingdom
THE OPERATIONAL EFFECTIVENESS OF UCAVS IN MOBILE TARGET ATTACK
Stewart, B. D., Defence Evaluation Research Agency, UK; Jul. 1998; 6p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper addresses a high-level approach to the analysis of uninhabited combat air vehicle (UCAV) effectiveness. The need for effectiveness analysis to take place in a range of realistic operational contexts is established, and the utility of effectiveness analysis is addressed. It is argued that it is necessary to take a 'system of systems' view in assessing UCAV effectiveness due to the diversity of impacts such systems will have on military operations. Relationships between some areas of UCAV performance, and their impacts on UCAV effectiveness, are presented as examples of the complexity of UCAV operations and to demonstrate the need for effectiveness analysis to assist in system definition.
Author
System Effectiveness; Systems Analysis; Pilotless Aircraft; Target Acquisition

19990007843 Aerospatiale, Defense Systems Preliminary Design Dept., Les Mureaux, France
CONOPS OF HALE UTA IN AN INFRARED EARLY WARNING MISSION FOR THEATER MISSILES DEFENSE
Gilibert, Herve, Aerospatiale, France; Thevenot, Regis, Aerospatiale, France; Jul. 1998; 8p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper presents the concept of High Altitude Long Endurance UTA equipped with Infrared sensors for Tactical Ballistic Missiles (TBM) detection and tracking. After a short presentation of the general context of operations in an Anti Tactical Ballistic Missile (ATBM) defense system, the IR HALE concept is depicted in its technical aspects as well as in its operational aspects: (1) analysis of potential "observable features" (signatures) of missiles, and crossing with general ATBM defense needs leading to introduce the IR HALE concept; (2) analysis of its potential performance levels in two major observation functions (missiles detection and tracking), derivation of a preliminary design; (3) exploration of major operational features (survivability,...); (4) synthesis of these elements: analysis of defense capabilities in typical TBM "Out of Area" scenery, potential roles inside global ATBM defense Systems, for Early Warning, and Weapon Systems commitment; (5) description of the command and control segment of such a system and its integration into air operations; and (6) brief overview of the other missions that can be envisioned for such a UTA. Concluding remarks highlight the position of the IR HALE UTA concept among other Early Warning / Cueing systems, both in terms of technical performance and military concept of employment.
Author
Early Warning Systems; Missile Defense; Ballistic Missiles; Pilotless Aircraft; Missile Tracking; Infrared Tracking; Remotely Piloted Vehicles

19990007845 Naval Air Warfare Center, Weapons Div., China Lake, CA United States
JOINT SEMI-AUTONOMOUS AIR WEAPON SYSTEM
Schwartz, R. W., Naval Air Warfare Center, USA; Millett, S. B., Naval Air Warfare Center, USA; Rogers, F. T., Naval Air Warfare Center, USA; Hedman, B., Naval Air Warfare Center, USA; Jul. 1998; 10p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Naval Air Warfare Center has investigated the idea of a semi-autonomous air weapon system that could be used in a lethal role. While such a system appears to be a natural continuation of military aviation we are just now beginning to appreciate some of the nuances inherent in such a system. In our approach we will not just "put weapons on UAV" or "take the pilot out of cockpit" either physically or mentally, or produce "more capable one-time use weapons". Rather our proposal for Joint Semi-Autonomous Air Weapon System (JSAAWS) is for a total weapon system designed for the tasks at hand. There are two lessons to be learned from history. The first lesson is that a new weapon concept such as JSAAWS must be designed for its intended application and not be just a retrofit of an existing system. The second lesson is that we need to develop JSAAWS in an orderly fashion, we need to walk before we run. Potential advantages of a JSAAWS for a Naval Expeditionary Force include increased survivability, decreased cost, increased lethality, via increased OPTEMPO and the ability of a JSAAWS to act as a force multiplier, and the ability to show a more aggressive presence when first-on-the-scene. In whatever role it plays, JSAAWS must be cost effective when compared to manned aircraft and one time use 'smart' weapons. One major contributor to cost savings would be greatly decreased operations and support costs due to vastly decreased flying hours. For example, life cycle cost could be reduced by 28% just from reduced flight hours. We have looked at several missions for a JSAAWS, some of which are more suitable for a JSAAWS then others.. These are: SEAD (the initial mission of choice for the operational community), Battlefield Support/ Simplification, Armed Recce, ASuW in the Littoral, supporting Operational Maneuver ... from the Sea, Counter Cruise Missiles, Offensive Counter Air, and Defensive Counter Air. Three notional system design concepts have been defined that cover all of the missions for a Naval Expeditionary Force. The high-end concept is the Highly Maneuverable Lethal Vehicle, which will be described in detail in paper 4 of this Conference. This would be a multi-role system for both air-to-air and air-to-surface missions. The air arsenal ship is a concept that has been put forward by the US Air Force. It would have limited air-to-air and air-

to-surface roles. The low-end concept would have capability in a limited, but operationally significant, set of air-to-surface missions, CAS, BAI, AI, SEAD, Indirect Fires. Included in this mission set is a significant percentage of the total targets for tactical combat aircraft.
Author
Weapon Systems; Systems Engineering; Weapons Development; Autonomous Navigation

19990007850 NASA Dryden Flight Research Center, Edwards, CA United States
OPERATIONAL CONCEPTS FOR UNINHABITED TACTICAL AIRCRAFT
Deets, Dwain A., NASA Dryden Flight Research Center, USA; Purifoy, Dana, NASA Dryden Flight Research Center, USA; Jul. 1998; 4p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

This paper describes experiences with five remotely piloted flight research vehicle projects in the developmental flight test phase. These projects include the Pathfinder, Perseus B, Altus, and X-36 aircraft and the Highly Maneuverable Aircraft Technology (HiMAT). Each of these flight projects was flown at the NASA Dryden Flight Research Center. With the exception of the HIMAT, these projects are a part of the Flight Research Base Research and Technology (R&T) Program of the NASA Aeronautics and Space Transportation Technology Enterprise. Particularly with respect to operational interfaces between the ground-based pilot or operator, this paper draws from those experiences, then provides some rationale for extending the lessons learned during developmental flight research to the possible situations involved in the developmental flights proceeding deployed uninhabited tactical aircraft (UTA) operations. Two types of UTA control approaches are considered: autonomous and remotely piloted. In each of these cases, some level of human operator or pilot control blending is recommended. Additionally, "best practices" acquired over years of piloted aircraft experience are drawn from and presented as they apply to operational UTA.
Author
Remotely Piloted Vehicles; Pilotless Aircraft; Research Vehicles; Highly Maneuverable Aircraft; Autonomous Navigation; Remote Control; Flight Control

19990007851 Defence Evaluation Research Agency, Air Systems Sector, Farnborough, United Kingdom
THE CHALLENGE OF UAV SUPPORTING OFFENSIVE AIR OPERATIONS
Frampton, R. A., Defence Evaluation Research Agency, UK; Jul. 1998; 6p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper provides an overview of some of the challenges facing the use of UAV in combat roles. Offensive roles are identified and the suitability of UAV for these discussed. The use of UAV for surveillance, target acquisition and reconnaissance is acknowledged as well established, the roles involving weapon delivery are less defined. The limitations on using UAV in combat roles are not seen dominantly as technical but more operational. The need to define the concept of operations for using UAV in combat is considered vital. Simulation is advocated to establish the viability of combat UAV concepts, conduct performance trade-off studies and to develop appropriate partitioning of control and decision making. Manned and un-manned platforms are seen as being complementary for the foreseeable future with UAV freeing up the manned platforms enabling them to undertake the roles needing flexibility. The major challenge is seen as establishing an environment in which both manned and un-manned platforms can work together effectively and safely.
Author
Pilotless Aircraft; Combat; Target Acquisition; Surveillance; Aerial Reconnaissance; Weapon Systems

19990007853 Sverdrup Technology, Inc., Eglin AFB, FL United States
MISSION RE-PLANNING FOR STANDOFF WEAPONS
Henne, Marlow, Sverdrup Technology, Inc., USA; Baker, James H., Air Force Development Test Center, USA; Jul. 1998; 12p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper frames a general discussion of current air campaign planning methods at the campaign and mission command echelons, and discusses the operational and technical mission re-planning requirements required for standoff weapons to engage fleeting targets or targets discovered immediately before or during a weapons delivery mission. Some weapon systems already have the technology needed to engage this threat; doctrinal advances and allocation of scarce sensor and weapons resources are the driving factors preventing effective fleeting target engagement.
Author
Mission Planning; Weapon Systems; Weapons Delivery; Target Acquisition; Target Recognition; Combat

19990007862 Defence Evaluation Research Agency, Weapons Sector, Farnborough, United Kingdom
UNMANNED TACTICAL AIR VEHICLES: AN ELECTRONIC COMBAT PERSPECTIVE
Langham, S. J., Defence Evaluation Research Agency, UK; Zanker, P. M., Defence Evaluation Research Agency, UK; Jul. 1998; 10p; In English; See also 19990007836; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This discussion paper, arising from project work at UK DERA, considers UTAVs from an electronic combat perspective. The paper will focus firstly upon their application to Electronic Combat roles, and secondly upon the problems of UTAV self protection by means of Defensive Aids Subsystems (DASS). UTAVs will find a variety of roles in the military operations of the future, both in conflict, and in operations other than war, such as peace-keeping and humanitarian aid. This paper identifies in general the various roles and scenarios which may become applicable to UTAVs. Current UTAVs are predominantly used for reconnaissance, however their near-term role is expanding to encompass communications relay, electronic warfare, environmental monitoring, target designation and the suppression of enemy air defences (SEAD) applications. The paper addresses the SEAD scenario, sensor payloads, airframe performance requirements and levels of threat faced. The SEAD role presents a particularly high risk for airframe survivability, as the UTAV is challenging the very threats which may be used against it. Such UTAVs are likely to carry advanced payloads, making for a high-value vehicle, requiring some measure of self-protection. Defensive aids will therefore feature in UTAV system designs. It is important to match the style of defensive aids to the roles and concepts of operation of the various types of vehicle envisaged. The style of self protection may be biased towards threat avoidance, confusion of air defences, or towards the countering of immediate threats. The paper discusses these styles of defensive aids systems, their cost and system drivers, and the types of components needed to realize them. The defensive aids suites could in most cases have to operate without manual intervention, and in this respect will be rather different to the traditional systems found in manned aircraft. The paper discusses these differences, and their implications in terms of system cost, complexity and effectiveness. The style of any countermeasure responses proposed for UTAVs may vary considerably according to the type of operation and the rules of engagement. Consideration must be given to the dangers of collateral damage, and even environmental damage, in certain circumstances. The paper discusses these considerations.
Author
Electronic Warfare; Air Defense; Pilotless Aircraft; Combat; Airframes

19990014361 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
THE INTERNATIONAL TEST AND TRAINING "RANGE"
VanNorman, C., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 48-52; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

This paper describes the test range of the year 2020 and its anticipated capabilities. It also describes technological and organization changes that are key to realizing this envisioned future test range. The discussion validates the need for a common development/test/training environment and points to the difficulties in establishing it. Although it might be desirable to locate all of this activity at a single place, such a concept would be prohibitive from both a fiscal and political standpoint. Thus, virtual integration of multiple, international facilities, laboratories, test ranges, simulated environments will be required to determine the weapons full capabilities for each mission scenario. This international integration must be carried out given the current fiscal

and geopolitical environment, while maintaining member nation security interests. The test and training "range" of the year 2020 will be a virtual not a physical place.
Derived from text
Test Ranges; Virtual Reality; Systems Integration

19990014372 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
COMMANDERS' DECISION AID FOR BATTLE PLANNING AND EXECUTION
vandenBroek, P., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 79-82; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Powerful computing equipment will enable the prediction of the evolution of a complex process such as a battle mission, and much faster than real time. This will be used to evaluate the effects of changes in battle plans, both changes in battle tactics and changes in allocated assets. Information networks, mission simulation and virtual reality technology will relieve the commander from much work by the presentation of any desired type of information in any quantity to the commander, but it should be kept in mind that all the decisions remain the full responsibility of the commander himself. The system, however sophisticated, has to provide all the possibilities to live up to this responsibility.
Author
Decision Support Systems; Real Time Operation; Mission Planning; Flight Simulation; Decision Making; Virtual Reality

67
THEORETICAL MATHEMATICS

Includes topology and number theory.

19970030251 Centre National de la Recherche Scientifique, Paris, France
FUNDAMENTALS OF FUZZY LOGIC, FUZZY INTERFERENCE AND FUZZY CONTROL
Bouchon-Meunier, B., Centre National de la Recherche Scientifique, France; Sep. 1997; 14p; In English; See also 19970030248; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Fuzzy set theory was introduced 30 years ago by L.A. Zadeh, with the purpose of formalizing the representation and management of imprecise or approximate knowledge, in order to facilitate the management of very complex systems, for instance systems involving human components. It provides tools to process imperfect information. In this paper, we introduce the basic elements of fuzzy set theory: definition of fuzzy sets; various operations f fuzzy sets; fuzzy relations; fuzzy arithmetics. We present possibility theory which allows to manage non-probabilistic uncertainty and leads to a form of reasoning on imperfect knowledge when used in synergy with fuzzy set theory. We present the bases of this approximate reasoning and we show how it can be used in inferences or in control.
Derived from text
Fuzzy Sets; Fuzzy Systems; Set Theory

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ACOUSTICS

19960003593 Tsentralni Aerogidrodinamicheskii Inst., Aerodynamics Div., Moscow, USSR
EXTERNAL NOISE OF SINGLE ROTOR HELICOPTERS
Samokhin, V. F., Tsentralni Aerogidrodinamicheskii Inst., USSR; Rozhdestvensky, M. G., Mil Moscow Helicopter Plant, Russia; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 8 p; In English; See also 19960003572; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Intensity, acoustical radiation spectrum, as well as single-rotor external noise level are analyzed in the paper based on the experimental data obtained from testing actual helicopters. The helicopter acoustical far-field is shown to be a superposition of the main and tail rotor fields. The external noise spectrum measured on the ground contains discrete and broadband components. Discrete component frequencies are multiples of the main and tail rotor passage frequencies and fall within the frequency ranges 20-160 Hz and 100-500 Hz respectively. Continuous spectrum radiation can be seen within the whole sound frequency range, but the maximum intensity is registered at 500-3,000 Hz frequencies. It has been found that the intensity of the helicopter acoustical radiation in the direction corresponding to the maximum external noise level and the power required by the main and tail rotors change according to the same law. The helicopter acoustical field is asymmetric relative to the vertical plane running through the longitudinal axis of the aircraft. The helicopter external noise level measured in PNdb has been found to be defined by the tail rotor acoustical radiation with a discrete frequency spectrum within 100-500 Hz and the continuous spectrum radiation within 500-3,000 Hz. The tail rotor configuration is shown to affect the helicopter acoustic response. Experimental studies of the external noise produced by the same helicopter first equipped with a tail rotor with symmetrical layout of the blades and then with an X-shaped tail rotor have allowed to establish that its tail rotor is the dominating source of the helicopter broadband noise. The X-shaped tail rotor has allowed to reduce the helicopter noise by 3-5 PNdb in level flight.
Author
Aeroacoustics; Aerodynamic Noise; Continuous Spectra; Far Fields; Frequency Ranges; Helicopters; Noise Intensity; Noise Measurement; Noise Reduction; Noise Spectra; Rotary Wings; Sound Pressure; Tail Rotors

19960003597 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany
INITIAL RESULTS FROM THE HIGHER HARMONIC CONTROL AEROACOUSTIC ROTOR TEST (HART) IN THE GERMAN-DUTCH WIND TUNNEL
Kube, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Splettstoesser, W. R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Wagner, W., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Seelhorst, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Yu, Y. H., Army Aviation Systems Command, USA; Boutier, A., Office National d'Etudes et de Recherches Aerospatiales, France; Micheli, F., Office National d'Etudes et de Recherches Aerospatiales, France; Mercker, E., Duits-Nederlandse Windtunnel, Netherlands; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 11 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Within a four nation research project jointly conducted by AFDD, NASA, ONERA, DLR and DNW the HHC effects on BVI noise and vibrations were investigated. The project had the objective to gain a physical understanding of the involved mechanisms and comprised theoretical as well as experimental studies. The latter ones were performed in the German Dutch Wind Tunnel (DNW) and had the overall goal to provide information about all relevant parameters. For that purpose, different measurement techniques like laser light sheet, laser doppler velocimetry as well as acoustic and non-intrusive blade deflection measurements were applied to a highly instrumented hingeless model rotor. All of these techniques were employed at different rotor conditions for different HHC settings, thus yielding a very comprehensive data base. It gives a physical insight in the mechanisms involved in BVI noise and vibration reduction by higher harmonic control and forms the basis for an improved understanding and modeling of these complex phenomena.
Author
Aeroacoustics; Aerodynamic Noise; Blade-Vortex Interaction; Flow Visualization; Harmonic Control; Noise Measurement; Noise Reduction; Nonintrusive Measurement; Pressure Distribution; Rotary Wings; Rotor Aerodynamics; Vibratory Loads; Wind Tunnel Tests

19960003599 Italian Aerospace Research Center, Acoustics Branch., Capua, Italy
CALCULATION OF HIGH-SPEED NOISE FROM HELICOPTER ROTOR USING DIFFERENT DESCRIPTIONS OF QUADRUPOLE SOURCE
Ianniello, S., Italian Aerospace Research Center, Italy; Debernardis, E., Italian Aerospace Research Center, Italy; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 7 p; In English; See also 19960003572; Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The problem of quadrupole noise prediction is addressed and treated through the acoustic analogy approach, comparing different solution forms for the FW-H equation including the nonlinear source term. In particular, results obtained using the volume integration of the quadrupole source are presented. A comparison is established with results from a set of acoustic Euler calculations; a comparative analysis of the computing time is conducted, and methods to reduce the computational effort requested by the volume integration are proposed. Then, a particular description of quadrupole source term is introduced, giving rise to some surface integrals. Their role is investigated in order to assess how they affect the quadrupole noise calculation.
Author
Aeroacoustics; Aerodynamic Noise; Helicopters; Noise Prediction (Aircraft); Numerical Integration; Quadrupoles; Rotary Wings; Rotor Blades; Transonic Flow

19960003601 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Design Aerodynamics., Brunswick, Germany
AEROACOUSTIC CALCULATION OF HELICOPTER ROTORS AT DLR
Schultz, K.-J., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Lohmann, D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Lieser, J. A., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Pahlke, K. D., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 19 p; In English; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The rotor noise level is one of the main design parameters for future rotorcrafts. This fact requires accurate aeroacoustic prediction tools. The two most annoying contributors to rotor noise radiation are blade vortex interaction impulsive noise (BVI) and highspeed compressibility impulsive noise (HI). At DLR great effort is concentrated on the two impulsive noise phenomena. The paper presents examples of (1) the prediction of lowspeed BVI impulsive noise using aerodynamic input from a quasisteady formulation of the panel method LBS and the linear terms of the FWH-equation for acoustic calculation, and (2) the prediction of highspeed hover and forward flight impulsive noise using transonic aerodynamic input from a 3D-EULER code and the FWH-equation including the nonlinear quadrupole term for the acoustic calculation. The calculated results are compared with experimental data from the AH-1/OLS (UH-1H) model tests in DNW,1982, and from the HELINOISE test (BO 105 model in DNW). The prediction of lowspeed BVI noise is highly dependent on the used wake model for the blade pressure calculation, while the acoustic calculation is quite straight forward. The comparison of experimental data with calculated acoustic results using blade pressure input from the LBS code in connection with Beddoes wake model shows satisfactory agreement. In the highspeed case the perturbation velocity field solution of the EULER code provides the input for the quadrupole volume integral in the FWH-equation. Four different solutions to solve the quadrupole term are presented for the hover case: volume integration, two kinds of pre-integration in blade normal direction and an approximation using the blade surface values. In comparison with experimental data the different calculated results for the hover case shows that the expensive volume integration provides the best solution, but the approximated approaches are also satisfactory. For the highspeed forward flight case the quadrupole approach with pre-integration has been selected and quite successfully applied.
Author
Aeroacoustics; Aerodynamic Noise; Blade-Vortex Interaction; Computational Grids; Helicopters; Horizontal Flight; Hovering; Noise Prediction (Aircraft); Panel Method (Fluid Dynamics); Pressure Distribution; Quadrupoles; Rotor Aerodynamics; Rotor Blades

19960003602 Eurocopter France, Dept. Aeromechanique., Marignane, France
PREDICTING HELICOPTER EXTERNAL NOISE: NUMERICAL METHODS AS CONCEIVED BY AN INDUSTRIALIST *PREVISION DU BRUIT EXTERNE DES HELICOPTERES: LES METHODES NUMERIQUES VUES PAR UN INDUSTRIEL*
Toulmay, Francois, Eurocopter France, France; Falchero, Danielle, Eurocopter France, France; Arnaud, Gilles, Eurocopter France, France; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 17 p; In French; See also 19960003572; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper investigates the methods used for rotor rotational noise, impulsive noise from blade/vortex interaction, high speed noise, rotor broadband noise, the various types of fenestron noise, and noise from the turboshaft engines. From the helicopter manufacturer's standpoint i.e. with respect to the prediction capability of the full chain of codes, including unsteady airloads calculation, an analysis of strengths and deficiencies is made and illustrated with experimental correlations. From this point of view, the fenestron is hovering flight and the rotational noise of rotors are both satisfactorily predicted, but in the event of interactions, the load calculation does not offer the full desired accuracy. Research regarding high speed noise is in progress and the research on broadband noise must be resumed. As regards turboengines, there is no alternative to the experimental approach for the helicopter manufacturer.
Author
Aerodynamic Loads; Aerodynamic Noise; Blade-Vortex Interaction; Helicopters; Hovering; Noise Prediction (Aircraft); Numerical Analysis; Rotor Aerodynamics; Rotor Blades; Unsteady Aerodynamics

19960003606 Purdue Univ., School of Aeronautics and Astronautics., West Lafayette, IN, United States
THE USE OF KIRCHHOFF'S METHOD IN ROTORCRAFT AEROACOUSTICS
Lyrintzis, Anastasios S., Purdue Univ., USA; AGARD, Aerodynamics and Aeroacoustics of Rotorcraft; Aug 1, 1995, 16 p; In English; See also 19960003572; Sponsored by Minnesota Supercomputer Inst. and Cray Research, Inc.; Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A comprehensive review of the use of Kirchhoff's method in rotorcraft aeroacoustics is given. Kirchhoff's integral formulation allows radiating sound to be evaluated based on quantities on an arbitrary control surface S if the wave equation is assumed outside. The control surface S is assumed to include all the nonlinear flow effects and noise sources. Thus only surface integrals are needed for the calculation of the far-field sound. A numerical CFD method can be used for the evaluation of the flow-field solution in the near-field and thus on surface S. Kirchhoff's integral formulation has been extended to an arbitrary, moving, deformable piecewise-continuos surface. The available Kirchhoff formulations are reviewed and various rotorcraft aeroacoustic applications are given. The relative merits of Kirchhoff's method are also discussed.
Author
Aeroacoustics; Aerodynamic Noise; Blade-Vortex Interaction; Computational Fluid Dynamics; Flow Distribution; Hovering; Kirchhoff Law of Radiation; Navier-Stokes Equation; Rotary Wing Aircraft; Rotor Aerodynamics; Transonic Flow

19960008955 Deutsche Aerospace A.G., Munich, Germany
NOISE ASSOCIATED TO ROCKET ENGINE TESTING AND NOISE REDUCTION MEASURE TAKEN ON DASA'S TEST FACILITIES IN OTTOBRUNN
Spagna, P., Deutsche Aerospace A.G., Germany; Schorer, E., Mueller-BBM G.m.b.H., Germany; AGARD, Environmental Aspects of Rocket and Gun Propulsion; Feb 1, 1995, 15 p; In English; See also 19960008937; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

The presented paper explains the environmental implications of noise resulting from rocket testing by means of an evaluation performed within the scope of the development tests of cryogenic liquid propellant engine components foreseen for the Ariane V launcher. An analysis of the different noise sources is carried out and the measures taken to perform noise reduction are presented. Finally, an outlook over the noise reduction measures in preparation for the case of other engine components, presently in development at DASA, is also given.
Author
Ariane Launch Vehicle; Engine Tests; Liquid Rocket Propellants; Noise Reduction; Rocket Engine Noise

19970025417 Eurocopter Deutschland G.m.b.H., Munich, Germany
REDUCTION OF THE NOISE SIGNATURE OF THE EUROCOPTER EC 135
Niesl, G., Eurocopter Deutschland G.m.b.H., Germany; Arnaud, G., Eurocopter France, France; Apr. 1997; 12p; In English; See also 19970025403; Copyright Waived; Avail: CASI; A03, Hardcopy; A04,

Microfiche

The paper presents an overview of the acoustic design of the EUROCOPTER EC 135 helicopter. The layout of the different noise relevant components were supported by measurements on the test bench and in the wind tunnel. The experimental and theoretical investigations were accompanied by acoustic measurement on the BO 105 and the BO 108. The results are discussed with respect to neighbourhood noise emission and acoustic detectability aspects. The low noise design of the fan-in-fin tail rotor (FENESTRON(R)) and the positive effect on the improved noise signature of the EC 135 is presented and compared to BO 105 and BO 108 with a conventional tail rotor. The main rotor of the EC 135 shows a reduced noise signature especially at higher Mach number due to the reduced blade thickness at the tip region, the introduction of a new airfoil generation, and an advanced blade shape. The low noise concept of the EC 135 is proved by noise measurements with ground based microphones.

Author

Military Helicopters; Noise Reduction; Noise Measurement; Helicopter Design; Aerodynamic Noise; Aircraft Noise; Acoustics

19970026382 Armstrong Lab., Bioacoustics and Biocommunications Branch, Wright-Patterson AFB, OH United States

AUDIO DISPLAY TECHNOLOGY

McKinley, Richard L., Armstrong Lab., USA; Jun. 1997; 8p; In English; See also 19970026380; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The scientific community has experienced substantial growth in knowledge and in the understanding of human auditory localization, particularly in recent decades. This background has spawned the concept of 3-dimensional (3-D) sound and has demonstrated that audio cues can be created and presented over headphones that indicate the location of sounds around the listener. This concept has been incorporated in prototype and commercial systems that synthetically create this virtual or 3-dimensional audio display. Spatial auditory information via 3-D audio displays, has demonstrated significant enhancements in target detection and acquisition, threat avoidance, voice communications enhancement, and situational awareness in laboratory investigations, simulators, and flight demonstrations. Numerous applications in both military and civilian arenas have been identified, and many demonstrated. Although significant enhancements have been obtained, ongoing work is required in the areas of display resolution, head related transfer functions with an emphasis on elevation cues, spatial auditory symbology, distance cues, and sensory interactions involving audio/visual and audio/visual/vestibular systems. Research and development will continue to enhance the understanding and performance of 3-D audio displays. Applications of this spatial auditory information technology will continue to expand in all areas providing even greater increases in user performance and safety.

Author

Voice Communication; Display Devices; Human Factors Engineering; Cockpits; Earphones; Sound Transmission; Auditory Perception

19980020565 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine

HIGH SPEED BODY MOTION AND SOUND GENERATION

Grinchenko, Victor T., Academy of Sciences of the Ukraine, Ukraine; High Speed Body Motion in Water; Feb. 1998; 7p; In English; See also 19980020532; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The accurate prediction of the sound field generated by movement in water bodies is important to control sources and reducing noise. Measurement and processing of hydrodynamic noise can give important information about the structure of flow around a body. One important feature of high speed flows around bodies is the presence of cavitation. An accurate simulation of the flow field past cavitation body is the first requisite in the computation of the radiated noise. The available models of flows that describe the cavitation flows do not give an adequate picture of the flow in all domains. So the data on noise in cavitation flows are based on experimental measurement. Some such experiments are discussed in the article. The estimation of acoustic efficiency of different kinds of flows is presented. Analysis of experimental data provides an estimation of Strouhal numbers in flows with different cavitation number.

Author

Sound Generators; Sound Fields; High Speed; Cavitation Flow

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19950017083 Institute for Aerospace Research, Structures, Materials and Propulsion Lab., Ottawa Ontario, Canada

DOUBLE PASS RETROREFLECTION FOR CORROSION DETECTION IN AIRCRAFT STRUCTURES

Komorowski, J. P., Institute for Aerospace Research, Canada; Krishnakumar, S., Institute for Aerospace Research, Canada; Gould, R. W., Institute for Aerospace Research, Canada; Bellinger, N. C., Institute for Aerospace Research, Canada; Karpala, F., Diffracto Ltd., Canada; Hageniers, O. L., Diffracto Ltd., Canada; AGARD, Corrosion Detection and Management of Advanced Airframe Materials; Jan 1, 1995, 12 p; In English; See also 19950017076; Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

An optical double pass retroreflection surface inspection technique (D Sight) used for visualizing surface distortions, depressions or pertrusions has been adapted as a rapid, enhanced visual inspection method inspection of large external aircraft surfaces. A project to fully characterize the D Sight indications of corrosion damage in lap splices is currently active. Over 150 large transport aircraft fuselage lap splice specimens have been collected. D Sight Aircraft Inspection System - (DAIS) 250C has been developed and tested both in the laboratory and in the field. In laboratory tests lap splices retrieved from retired aircraft and subjected to accelerated corrosion and lap splices naturally corroded in-service were inspected with DAIS, eddy current, X-ray, shadow moire and subjected to tear down. It has been shown that the DAIS 250C is capable of locating corrosion pillowing indicative of a thickness loss as low as 2 percent. The first field trial of the DAIS 250C was based on two service bulletins requiring inspection of longitudinal and circumferential lap splices on the 737-200 aircraft from BS 259.5 to BS 1016. The DAIS 250C inspection, including analysis and report, took 36 man-hours. The recommended technique in the SB was close visual inspection and the time required according to the service bulletins, was 278 man-hours.

Author

Aircraft Structures; Corrosion; Damage; Inspection; Nondestructive Tests; Retroreflection; Surface Distortion

19950025709 Officine Galileo S.p.A., Florence, Italy

OPTIMAL INFRARED DETECTOR CONFIGURATIONS FOR AIR TARGET DETECTION

Uda, G., Officine Galileo S.p.A., Italy; Barani, G., Officine Galileo S.p.A., Italy; AGARD, Guidance and Control for Future Air-Defence Systems; Jan 1, 1995, 10 p; In English; See also 19950025702; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The airtarget detection by a thermal camera is a typical problem of 'hot spot detection' and the knowledge of the available energy on the infrared sensor becomes a critical item to analyse. In order to evaluate the performances of an infrared system in search and track threat warning or passive surveillance, it is necessary to compute the Signal to Noise Ratio (SNR) of the system. The maximization of the SNR is an important goal to assure long detection ranges against stealth threats or cruise missiles with very low emissivities. The large number of detectors is just one of the requirements for this kind of application and some energetic considerations lead up to consider particular geometrical array configurations. Usually, in the SNR evaluation it is assumed that all the energy from a target is focused by the optical system on a single detector element of the array. However, the image of a point source on the focal plane has a finite extent (spot) and its energy distribution is given by the Point Spread Function (PSF) of the optics. The interaction of the finite spot size with the array gives rise to a spreading of the energy impinging on the individual detectors, which causes a decrease of performances. In this paper a statistical evaluation of the loss of energy impinging on the detector due to the finite image size of point targets was performed through a Monte Carlo simulation. by considering the maximum of the energy integrated by

a single detector, it is possible to compute the effective SNR of the system. A new figure of merit, called Spreading Factor (SF), defined as the ratio between the maximum of the energy integrated by the single detector of the array and the total energy subtended by the PSF, permits to evaluate the capability of a detector array to detect point sources. Some typical detector and system configurations with their technological impacts have been examined.
Author
Cameras; Infrared Detectors; Mathematical Models; Missile Detection; Monte Carlo Method; Point Sources; Point Spread Functions; Remote Sensors; Statistical Analysis; Surveillance; Target Acquisition; Target Recognition

19960003873 Yale Univ., Dept. of Applied Physics., New Haven, CT, United States
NONLINEAR OPTICAL EMISSION AND SCATTERING IN MICROMETER-SIZED DROPLETS
Chen, Gang, Yale Univ., USA; Mazumder, Md. Mohiuddin, Yale Univ., USA; Swindal, J. Christian, Yale Univ., USA; Schaschek, Karl, Yale Univ., USA; Chang, Richard K., Yale Univ., USA; AGARD, High Power Microwaves (HPM), Volume 1; Mar 1, 1995, 9 p; In English; Sponsored by AFOSR
Contract(s)/Grant(s): DAAH04-94-G-0031; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Absorption of high peak power microwaves by water droplets can induce a spatially inhomogeneous temperature rise inside the droplet, thereby affecting the droplet evaporation rate and surface tension. A minute decrease of the droplet radius and small amounts of shape distortion can be readily detected by analyzing the changes in the nonlinear optical emission from perturbed droplets. In the visible wavelength region, a micrometer-sized droplet acts as an optical cavity that provides high-Q optical feedback for the nonlinearly generated radiation, such as lasing. Cavity resonances occur at discrete wavelengths that are commensurate with the integer number of wavelengths that can fit into the droplet perimeter. Intense nonlinear emission occurs whenever the round-trip gain is larger than the round-trip leakage from the droplet rim. A decrease of the droplet radius for example, associated with an increased evaporation rate, will cause all the nonlinear emission peaks to shift to shorter wavelengths. A shape distortion will cause the wavelengths of the nonlinear emission to vary along the droplet rim because the perimeters of the great ellipses change along the rim. Examples will be presented as to how spectral changes in the nonlinear emission can be used as a sensitive diagnostic probe of the size changes and shape distortions of flowing micrometer droplets.
Author
Cavity Resonators; Drop Size; Drops (Liquids); Laser Induced Fluorescence; Nonlinear Optics; Optical Resonance; Precipitation Particle Measurement; Surface Distortion

19960003885 Aerospatiale, Cannes, France
EXPERIENCE ACQUIRED BY AEROSPATIALE IN THE FIELD OF THE INTEGRATION OF HIGH RESOLUTION OPTICAL PAYLOADS
EXPERIENCE ACQUISE PAR L'AEROSPATIALE DANS LE DOMAINE DE L'INTEGRATION DE CHARGES UTILES OPTIQUES HAUTE RESOLUTION
Mendez, J., Aerospatiale, France; Leblanc, J. M., Aerospatiale, France; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 6 p; In French; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The suggested subject relates to the experience gained by the Aerospatiale establishment of Cannes in the field of optical payloads integration. Within the framework of the activities relating to the space observation, important investments were carried out in Cannes with the aim being the ability to integrate optical instruments of very high performances. The objective of this communication suggested within the framework of symposium AGARD 1994 is to present the innovations which were necessary to ensure the integration and performances control of the high resolution optical payload, as well as the methods that are developed for the ground testing facilities. We will not treat the intrinsic characteristics of this optical instrument nor of its mission.
Transl. by CASI
High Resolution; Instrument Packages; Optical Equipment; Payload Integration; Payloads

19960007249 Naval Postgraduate School, Academic Center for Infrared Technology., Monterey, CA, United States
POLARIZATION ENHANCEMENT OF CONTRAST IN INFRARED SHIP/BACKGROUND IMAGING
Cooper, A. W., Naval Postgraduate School, USA; Lentz, W. J., Naval Postgraduate School, USA; Walker, P. L., Naval Postgraduate School, USA; Chan, P. M., Naval Postgraduate School, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 10 p; In English; See also 19960007226; Sponsored by Johns Hopkins Univ.
Contract(s)/Grant(s): ORDER-MP95543725; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

During the MAPTIP (Marine Aerosol Properties and Thermal Imager Performance) experiment series in Dutch coastal waters in October 1993 shore-based polarized infrared images were recorded of air (fixed wing and helicopter) and sea targets in sea and air backgrounds, including a number of vertically and horizontally polarized image pairs of the Dutch oceanographic research vessel Hr Ms Tydeman. Complete characterization of the environmental conditions in the measurement area will be available through other MAPTIP participants. These images show no significant polarization features in ship images (less than 5%) or in sky background, but a considerable degree of vertical ('p') polarization in the sea background radiance at low emission (near grazing) angles, which is ascribed to surface emission polarization. This phenomenon for all observed times of day and sun positions, and more strongly in the LWIR than in the MWIR. A horizontal polarization filter provided 10 to 20% ship-to-sea contrast improvement due to suppression of sea background, and enhances horizon sea/sky contrast by up to 15%. These results are consistent with our previous measurements of polarization in the sun glint channel.
Author
Coastal Water; Image Analysis; Imaging Techniques; Infrared Imagery; Polarized Radiation; Thermal Mapping

19960007257 Naval Command, Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Div., San Diego, CA, United States
A FLIR CASE STUDY USING THE ELECTRO-OPTICAL TACTICAL DECISION AID (EOTDA) MARK 3
Mcgrath, Charles P., Naval Command, Control and Ocean Surveillance Center, USA; AGARD, Propagation Assessment in Coastal Environments; Feb 1, 1995, 8 p; In English; See also 19960007226; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

This report compares measured forward-looking infrared (FLIR) system detection ranges of a target ship, the Research Vessel Point Sur, with predictions from the Electro-Optical Tactical Decision Aid (EOTDA) version 3.0. The EOTDA was primarily developed by the Air Force, with only minimal attention applied to the complexities of the marine environment. The objective of this case study was to evaluate the infrared EOTDA performance for a target in an open ocean background. Surface meteorological and navigation data were recorded aboard the Point Sur. Eight FLIR missions were flown making 57 detection range measurements. The meteorological and navigation data were input to the EOTDA, and the prediction ranges were tabulated and compared with the reported FLIR data. Results showed reasonable accuracy during the clear-weather portion of the tests, but the EOTDA grossly overpredicted detection ranges when a stratus cloud ceiling prevailed. Attempts to determine integrated target temperature from thermistors mounted on the surface of the ship structure were unsuccessful. Since calibrated target and background temperatures were unavailable at the times of the FLIR detection range measurements, it was not possible to isolate the portion of the EOTDA most responsible for the overpredictions. However, the transmission model, LOWTRAN 7, has been thoroughly exercised and is well accepted. The target model (TCM2) of the EOTDA performed well in another case study during the same field tests. This would make the

water background model of the EOTDA most suspect. Further investigation of the water, sky, and cloud radiance models of the EOTDA is recommended, especially in the marine environment.
Author
Electro-Optics; FLIR Detectors; Marine Environments; Meteorological Parameters; Oceans; Target Acquisition; Target Recognition

19960008187 Rome Univ., Dipt. di Fisica., Rome, Italy
OPTICS AND NONLINEAR OPTICS FOR SIGNAL PROCESSING AND COMPUTING APPLICATIONS
Crosignani, Bruno, Rome Univ., Italy; AGARD, Optical Processing and Computing; Sep 1, 1995, 28 p; In English; See also 19960008186; Avail: CASI; A03, Hardcopy; A02, Microfiche

Some basic optical concepts are presented which are at the basis of development and implementation of devices to be used in the frame of optical processing and computing. The optical processes presented are spatial Fourier transformation property of thin lenses, holography, two-beam coupling in a fixed grating, the photorefractive effect and real-time holography, optical four-wave mixing, convolution and correlation via four-wave mixing, phase conjugate Michelson interferometer and parallel image subtraction, and image amplification.
CASI
Nonlinear Optics; Optical Computers; Optical Data Processing; Photonics; Signal Processing

19960008191 California Inst. of Tech., Pasadena, CA, United States
ULTRA-FAST NONLINEARITIES IN SEMICONDUCTOR OPTICAL AMPLIFIERS FOR APPLICATIONS IN ALL-OPTICAL NETWORKS
Vahala, Kerry J., California Inst. of Tech., USA; Zhou, Jianhui, California Inst. of Tech., USA; Park, Namkyoo, California Inst. of Tech., USA; Newkirk, Mike, Bell Telephone Labs., Inc., USA; Miller, Barry, Bell Telephone Labs., Inc., USA; AGARD, Optical Processing and Computing; Sep 1, 1995, 31 p; In English; See also 19960008186; Avail: CASI; A03, Hardcopy; A02, Microfiche

Ultra-fast intraband occupancy relaxation in semiconductor gain media has recently been shown to provide a wide band nonlinearity which is several orders of magnitude larger than the Kerr nonlinearity in silica fiber. We address recent work directed towards applications of nonlinearity to the wavelength conversion function in all optical networks; specifically, carrier wavelength spectral translation by four-wave mixing. In addition to reviewing the current performance of these devices including conversion efficiency, signal to noise, and a simple system demonstration, we will discuss the underlying physics of the ultra-fast four-wave mixing mechanism and its application to TeraHertz spectroscopy of intraband scattering. An overview of wavelength conversion in the context of all optical networks is provided and competing techniques to four-wave mixing wavelength conversion are also discussed.
Author
Four-Wave Mixing; Frequency Converters; Light Amplifiers; Nonlinear Optics; Optical Communication; Semiconductor Devices; Traveling Wave Amplifiers

19980203996 Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese, Belgium
SURFACE INTEGRAL METHOD TO QUANTIFY THE DROPLET NON-SPHERICITY EFFECT ON RAINBOW THERMOMETRY
vanBeeck, J. P. A. J., Von Karman Inst. for Fluid Dynamics, Belgium; Riethmuller, M. L., Von Karman Inst. for Fluid Dynamics, Belgium; May 1998; 8p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A theoretical model is presented to compute the monochromatic rainbow interference pattern formed by ellipsoidal homogeneous, transparent particles. The model is applied to predict the effect of droplet nonsphericity on the errors in the particle temperature and size measurements, performed by rainbow thermometry. These results have been employed to achieve a quantitative validation of the experimental nonsphericity detection method, based on the comparison of different types of size measurements of the same droplet, derived from different interference structures that are visible in the rainbow pattern. As such, confidence can be established in the temperature measurement as far as the selected spherical droplets are concerned.
Author
Temperature Measurement; Drops (Liquids); Laser Doppler Velocimeters; Laser Beams

19980204002 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia
APPLICATION OF OPTICAL AND INTERFERENCE METHODS IN EXPERIMENTAL AERODYNAMICS
Koulech, V. P., Tsentralni Aerogidrodinamicheskii Inst., Russia; Fonov, S. D., Tsentralni Aerogidrodinamicheskii Inst., Russia; Yakovlev, V. A., Tsentralni Aerogidrodinamicheskii Inst., Russia; May 1998; 12p; In English; See also 19980203985; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The review of optical methods, which were developed and used during the last years in TsAGI for investigations of aircraft aerodynamics and aeroelasticity, is presented. Non-traditional methods of flow investigations are considered in more detail: a raster-type shadowgraph method of flow visualization, laser interferometry with a narrow reference beam, shift interferometry and laser holographic interferometry, a laser-knife method. The combination of visualization by a laser-knife method with local measurements of velocity distribution with the help of a laser Doppler velocimeter (LDV) is offered, which allows to optimize a grid of nodes of velocity measurement. To study the shape, motion and deformation of the aerodynamic models and aircraft structure elements in aerodynamic wind tunnels a number of optical, laser and videogrammetric systems ensuring high sensitivity and processing of results in real time is developed.
Author
Aerodynamics; Velocity Measurement; Velocity Distribution; Real Time Operation; Laser Interferometry; Laser Doppler Velocimeters; Holographic Interferometry; Flow Visualization

19980204003 Institut de Mecanique des Fluides de Lille, France
RECORDING AND PROCESSING OF INTERFEROGRAMS BY SPECTRAL DESCRIPTION OF THE OPTICAL SEQUENCE *ENREGSTREMENT ET TRAITEMENT DES INTERFEROGRAMMES PAR CARACTERISATION SPECTRALE DE LA CHAINE OPTIQUE*
Desse, J. M., Institut de Mecanique des Fluides de Lille, France; May 1998; 8p; In French; See also 19980203985; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The recording and processing of interferograms are greatly improved by the opportunity to be able to recreate in a microcomputer equipped with an image processing card the scale of experimental shadings of an interferometer equipped with a known white source and a given Wollaston prism. Considering the spectral characteristics of the light source and the three filters of the RVB video camera, one is able to express analytically the luminous strength of the interference fringes when the operating difference varies and to reproduce on the monitor the colors which are going to be displayed experimentally. Knowledge of the shading scale of the interferometer will allow one on the one hand to control in an optimal way the position of the prism during recording of the photographs, and on the other hand to process the interferograms automatically and with very high precision.
Transl. by Schreiber
Interferometers; Image Processing; Interferometry

19980206019 Innovative Scientific Solutions, Inc., Beavercreek, OH United States
OPTICAL MEASUREMENTS OF SURFACE PRESSURE AND TEMPERATURE IN TURBOMACHINERY
Navarra, Kelly, Innovative Scientific Solutions, Inc., USA; Goss, Larry, Innovative Scientific Solutions, Inc., USA; Jordan, Jeffery, Innovative Scientific Solutions, Inc., USA; Rabe, Doug, Wright Lab., USA; Gord, Jim, Wright Lab., USA; Car, David, Wright Lab., USA; May 1998; 14p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A new pressure-measurement technique which employs the tools of molecular spectroscopy has recently received considerable attention in the aerospace community. Measurements are made via oxygen-sensitive molecules attached to the surface of interest as a coating, or paint. The pressure-sensitive-paint (PSP) technique is now commonly used in stationary wind-tunnel tests; this paper presents extension of the technique to advanced turbomachinery applications. New pressure- and temperature-sensitive paints (TSPs) have been developed for application to a state-of-the-art transonic compressor where pressures up to 2 atm and surface temperatures to 140 C are expected for the first-stage rotor. PSP and TSP data images have been acquired from the suction surface of the first-stage rotor at 85% of the correct design speed for the compressor peak-efficiency condi-

tion. The shock structure is clearly visible in the pressure image, and visual comparison to the corresponding computer prediction shows quantitative pressures similar to the PSP data. The measurement error is estimated to range from 0.36 kPa in low pressure regions to 4 kPa in high-pressure regions. The errors were significantly increased by a failure mode of the camera which will be described.
Author
Paints; Surface Temperature; Optical Measurement; Pressure Measurement; Molecular Spectroscopy; Transonic Compressors; Wind Tunnel Tests; CCD Cameras

19980206028 Massachusetts Inst. of Tech., Gas Turbine Lab., Cambridge, MA United States
OPTICAL INSTRUMENTATION FOR TEMPERATURE AND VELOCITY MEASUREMENTS IN RIG TURBINES
Ceyhan, I., Massachusetts Inst. of Tech., USA; dHoop, E. M., Massachusetts Inst. of Tech., USA; Guenette, G. R., Massachusetts Inst. of Tech., USA; Epstein, A. H., Massachusetts Inst. of Tech., USA; Bryanston-Cross, P. J., Warwick Univ., UK; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Non-intrusive optical measurement techniques have been examined in the context of developing robust instruments which can routinely yield data of engineering utility in high speed turbomachinery test rigs. The engineering requirements of such a measurement are presented. of particular interest were approaches that provide both velocity and state-variable information in order to be able to completely characterize transonic flowfields. Consideration of all of the requirements lead to the selection of particle image velocimetry (PIV) for the approach to velocity measurement while laser induced fluorescence of oxygen (O2 LIF) appeared to offer the most promise for gas temperature measurement. A PIV system was developed and demonstrated on a transonic turbine stage in the MIT blowdown turbine facility. A comprehensive data set has been taken at one flow condition. Extensive calibration established the absolute accuracy of the velocity measurements to be 3-5 %. The O2 LIF proved less successful. Although accurate for low speed flows, vibrational freezing of O2 prevented useful measurements in the transonic, 300-600 K operating range of interest here.
Author
Laser Induced Fluorescence; Particle Image Velocimetry; Velocity Measurement; Temperature Measurement; Test Stands; Gas Temperature; Supersonic Turbines

19980206031 Technische Univ., Electronics and Measurement Technology Dept., Munich, Germany
OPTICAL BLADE VIBRATION MEASUREMENT AT MTU
Zielinski, M., Technische Univ., Germany; Ziller, G., Technische Univ., Germany; May 1998; 10p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Compressor rotor blade vibration measurements are crucial to the proper assessment of critical operating conditions and the prediction of blade life. Generally, at MTU these measurements are performed using strain gauges or the frequency-modulated grid system. In an attempt to provide an advanced alternative solution to the two standard techniques, MTU commenced work on an optical blade vibration measurement (OBM) system some years ago. For OBM, several optical trigger probes are installed in the compressor casing above the rotor, and the blade transit times between the probes are measured. An analysis of these transit times then provides information on blade vibrations. This paper describes the details of MTU's experimental OBM system and the analysis methods used. The capability of the system is demonstrated by means of various measurement tasks: vibrations excited by resonances with amplitudes as low as 10 micro-m(p) can be measured. Blade vibrations caused by compressor surges were analysed successfully. Comparative measurements show good agreement between OBM and strain gauge results. As an option the untwistness of the blades with increasing rotational speed can be measured.
Author
Vibration Measurement; Optical Measuring Instruments; Compressor Blades; Structural Vibration

19980206034 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
NON-INTRUSIVE MEASUREMENT OF AN ENERGETIC MATERIAL REGRESSION RATE *MESURE NON-INTRUSIVE DE LA VITESSE DE REGRESSION D'UN MATERIAU ENERGETIQUE*
Cauty, Franck, Office National d'Etudes et de Recherches Aerospatiales, France; May 1998; 12p; In French; See also 19980206002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The non-intrusive method of an energetic material regression rate determination developed by ONERA is based on the ultrasound wave propagation time through the tested material. This direct, local and quasi-instantaneous method is aimed at determining the classical burning rate law of solid propellants in large pressure and initial temperature ranges. This technique demonstrates a good accuracy in various combustion regimes, specially in erosive burning, and for different solid propellants. Significant examples are presented in solid propellant domain. The application field of the ultrasound method extends to other materials for hybrid propulsion or thermal protective insulator degradation. The ONERA ultrasonic method and its associated electronic devices are operating either as an industrial procedure tool for solid propellant manufacturing or as a helpful diagnostic tool for research engineers.
Author
Ultrasonics; Nonintrusive Measurement; Solid Propellants; Propellant Combustion; Burning Rate

19980206036 Rolls-Royce Ltd., Applied Science Lab., Derby, United Kingdom
DEVELOPMENTS IN HIGH ENERGY X-RAY RADIOGRAPHY OF RUNNING ENGINES
Allen, M. J., Rolls-Royce Ltd., UK; Rogers, J. D., Rolls-Royce Ltd., UK; May 1998; 8p; In English; See also 19980206002; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

There has been substantial industrial development of radiographic techniques for quantitative measurement of component and/or material clearances or movement within static or operating test pieces or machinery. Important examples of applications are in the fields of aeronautics, armaments, space sciences, and nuclear engineering. Following the demonstration and installation of a suitable high energy X-ray source for use with operating aero-engines, Rolls-Royce has been routinely carrying out high-energy X-ray radiography of engines on test beds since 1971. The current Rolls-Royce X-ray imaging equipment includes a film plate changer system, used for analysis of steady-state or slow transient events that enables sequences (up to 10 shots) of high-resolution film radiographs to be obtained at short (approx. 2 s) exposure times. A real-time X-ray video imaging system producing up to 25 frames/s is used for faster transients or where cyclic behavior is being investigated by strobing with the pulsed X-ray source. An Electronic Radiography imaging system, based on a cooled high-resolution CCD camera, has been developed to replace film radiography. This system enables long sequences (more than 100 images) of high resolution images to be obtained at fast data acquisition and transfer rates (up to 8 x 10(exp 6) pixel/s). Movements of regions of interest in sequences of images during an engine operating cycle are measured using cross correlation tracking software. The performance of a new Rolls-Royce imaging system for test bed use is discussed and the results of an X-ray test on an Adour engine are described.
Author
Radiography; X Ray Inspection; X Ray Imagery; CCD Cameras; Static Tests; Real Time Operation; Nondestructive Tests; Images

19980210660 Wright Lab., Targeting Systems Branch, Wright-Patterson AFB, OH United States
ADVANCED ELECTRO OPTIC TARGETING SYSTEM
Jacobs, Richard W., Wright Lab., USA; Lapp, Henry S., Wright Lab., USA; Multi-Sensor Systems and Data Fusion for Telecommunications, Remote Sensing and Radar; Apr. 1998; 7p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

Future Aircraft targeting systems are integrating sensor inputs for automated target detection, location and identification with the goal to both lower system cost and increase system performance. This paper describes a common aperture electro optical (EO) targeting concept for an integrated air-to-ground EO targeting system using promising developments in multispectral target detection and in laser target iden-

tification. The integrated capability allows use of a minimum system aperture while increasing recognition and targeting ranges outside missile treat envelopes. The technical status and preliminary test results of the Wright Laboratory thrusts to develop both laser identification and thermal spectral detection capabilities will be discussed. These involve developments and demonstrations of multi-spectral detection using a few thermal bands and non-cooperative target identification using a burst illumination laser with eyesafe wavelength and a short wave infrared gated camera. These individual concepts will be mature enough to support an integration effort in the 1999/2000 timeframe. The cost, performance and level of automation supports use for both manned and unmanned air vehicle targeting and reconnaissance missions.
Author
Target Acquisition; Infrared Radiation; Electro-Optics; Laser Targets; Missiles

19980210686 Wright Lab., Materials Directorate, Wright-Patterson AFB, OH United States
PIXELLESS INFRARED IMAGING USING QUANTUM WELLS
Brown, Gail J., Wright Lab., USA; Szmulowicz, Frank, Wright Lab., USA; Apr. 1998; 7p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

A new concept for designing infrared imaging systems is under development. In this concept, absorbed long wavelength infrared light is up-converted to near infrared emission through the vertical integration of a p-type multiple quantum well infrared photodetector (QWIP) heterostructure and a light emitting diode (LED). The infrared (IR) radiation is absorbed in the QWIP part of the heterostructure. The optically excited charge carriers from the QWIP are used to stimulate near IR emission from the LED layers. This emitted radiation can then be imaged using a commercial, high resolution silicon CCD camera. Because of the extremely short path that the photoexcited charge carrier traverses between the QWIP and LED layers, the emitted photon originates at the same spatial position as the absorbed photon, such that there is a one-to-one correspondence between the long wavelength infrared image and the near infrared image. With this device, the need for fabricating thousands of tiny pixels on the infrared array to generate a high resolution image is eliminated. With the elimination of pixels comes the elimination of the need for thousands of contacts to apply a bias voltage to each individual pixel. Only two wires are required to bias this QWIP and LED heterostructure. For a two color infrared system, this concept would require only three wires for the entire large area imaging array. Our preliminary results for a vertically integrated p-type GaAs/AlGaAs QWIP and LED heterostructure will be discussed.
Author
Quantum Wells; Semiconductors (Materials); Pixels; Imaging Techniques; Infrared Imagery; Photoexcitation; Charge Carriers

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THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics. For related information see also 25 Inorganic and Physical Chemistry and 34 Fluid Mechanics and Heat Transfer.

19970009250 Daimler-Benz Aerospace A.G., Militarflugzeuge, Munich, Germany
AEROTHERMODYNAMICS OF RADIATION-COOLED SURFACES
Hirschel, E. H., Daimler-Benz Aerospace A.G., Germany; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 16p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This lecture introduces to the aerothermodynamics of radiation-cooled surfaces of high-speed flight vehicles operating in the earth atmosphere at speeds below approximately 8 km/s. After a discussion of the technical background of heat loads at hypersonic flight, a simple analysis shows how the radiation-adiabatic temperature qualitatively depends on the local boundary-layer properties. Computed examples illustrate the findings and show the implications of radiation cooling for the vehicle design. Scaling laws and non-convex effects are treated, and the influence of radiation cooling on several surface phenomena is considered. Finally, the need of a hot experimental technique is discussed and a possible integrated aerothermodynamic design approach is sketched.
Author
Aerothermodynamics; Radiant Cooling; Hypersonic Flight

19970009253 Dassault Aviation, Saint-Cloud, France
CONFIGURATIONAL AEROTHERMODYNAMICS OF RAM AND SCRAM PROPELLED VEHICLES
Perrier, P., Dassault Aviation, France; Courty, J. C., Dassault Aviation, France; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 36p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Numerical and experimental tools are available for effective design of RAM and SCRAM propelled vehicles. Taking into consideration that flight conditions are not well duplicated in wind tunnel tests for high entropy flow, performance prediction should be supported by both calculations and experiments. An efficient multidisciplinary approach should account for all constraints placed by aerothermal and aerodynamic factors.
Derived from text
Aerothermodynamics; Performance Prediction; Aerodynamic Configurations; Aircraft Configurations; Hypersonic Vehicles

19970009258 Aerospatiale Missiles, Chatillon, France
MISSILE AEROTHERMODYNAMICS AND PROPULSION INTEGRATION
Pagen, D., Aerospatiale Missiles, France; Lacau, R.-G., Aerospatiale Missiles, France; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 44p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

This lecture provides a general review of aerothermodynamics and propulsion integration of supersonic and hypersonic missiles. We focus on the major design problems and the simulation means with their potentials and deficits. Considered design problems are external aerothermodynamics, including the specific problem of lateral jet control, and the ramjet/scramjet propulsion integration. Simulation means cover Computational Fluid Dynamics (CFD) tools as well as ground test facilities. The last part of the lecture illustrates the feasibility to use CFD tools in the design process as a complementary approach to wind tunnels, propulsion benches and flight tests.
Author
Aerothermodynamics; Missiles; Propulsion System Performance; Supersonic Combustion Ramjet Engines; Systems Integration; Computational Fluid Dynamics

19970009259 Daimler-Benz Aerospace A.G., Space Infrastructures, Munich, Germany
STAGE SEPARATION AEROTHERMODYNAMICS
Weiland, Claus, Daimler-Benz Aerospace A.G., Germany; Aerothermodynamics and Propulsion Integration for Hypersonic Vehicles; Oct. 1996; 28p; In English; See also 19970009247; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Aerothermodynamic problems during the sequence of ascent flight are investigated. The flows for the pickaback configuration, the stage separation, the lower stage alone, inside of the trough of the lower stage and the fin/winglet interaction are considered. The main attention will be drawn to the stage separation process. During hypersonic flight the upper stage is separated from the lower stage which induces thereby a highly complicated flow field in the gap between the both stages, leading to aerodynamic and thermal loads. From the flight mechanical point of view the aerodynamic coefficients have to be determined, whereas for structures and thermal protection purposes the local loads are of most importance. Several physical aspects are examined for the various kinds of flows, i.e., wall radiation, turbulence, real gases, shock/boundary layer and shock/shock interaction, flow separation and reattachment. The flowfields are analyzed by employing numerical simulation methods as well as wind-tunnel experiments. Inviscid and viscous numerical simulations are performed applying the Euler and the Navier-Stokes equations. The influence of the grid fineness on the accuracy of the numerical results are also object of consideration. Results of the above described flow

cases will be presented and discussed in very detail and the wind-tunnel data will be compared with the numerical results for validation reasons.
Author
Stage Separation; Aerothermodynamics; Ascent; Hypersonic Speed; Flow Distribution; Separated Flow; Shock Wave Interaction; Navier-Stokes Equation; Computational Fluid Dynamics

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ADMINISTRATION AND MANAGEMENT

19960003895 Centre National d'Etudes Spatiales, Toulouse, France
S2000+ OR PRELIMINARY DESIGN OF SPACE SYSTEMS *S2000+ OU LA CONCEPTION PRELIMINAIRE DES SYSTEMES SPATIAUX*
Gory, J. F., Centre National d'Etudes Spatiales, France; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 7 p; In French; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

As in all other industries, the space industry is evolving in three primary areas: technology, costs and socioorganisational approaches. A project conducted in CNES aims to revise the definition of future space systems with the introduction of global methods and computer-aided tools. One of the main goals is the definition and the development of a Workbench for missions and space systems design. It will be composed of a certain number of design and simulation tools dealing with unique and coherent information shared between different viewpoints. Operated in CNES, this computer-hased Workbench will focus on the early stages of projects but will also treat first order or 'simplified' models which are managed daily during the projects' life span, in accordance with the detailed models from industry.
Author
Aerospace Systems; Computer Techniques; Computerized Simulation; Systems Engineering

19980016572 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugfuehrung, Brunswick, Germany
INTELLIGENT DECISION AIDS FOR HUMAN OPERATORS
Winter, H., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Champigneux, G., Dassault Aviation, France; Reising, J., Wright Lab., USA; Strohal, M., Universitaet der Bundeswehr Muenchen, Germany; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 2; 20p; In English; See also 19980016571; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

The paper describes the concepts and architectures of intelligent decision aids, which are designed to support human operators in complex mission systems. It starts with a discussion of models for human decision making. These models are used to develop the concepts for intelligent technical devices - like monitoring or diagnosis systems for situation assessment, planning or decision aiding systems for the preparation of actions - which are built to support certain subfunctions in the human decision making process. Several examples of decision aids are presented, which have been developed in the USA, France and Germany. The goal is that the detailed presentation of these projects, together with the discussion of experiences and lessons learned from the implementations shall help potential builders of intelligent decision aids to design similar systems. The areas of application of these decision aids range from air vehicle management and aircraft mission management to air traffic management and command and control systems. The principle of coupling work systems for the modelling of complex and distributed decision making processes is discussed and applied to air traffic management and command and control.
Author
Decision Support Systems; Human Factors Engineering; Artificial Intelligence; Decision Making; Operators (Personnel); Control Systems Design; Human-Computer Interface; Problem Solving

19980033524 British Aerospace Defence Ltd., Military Aircraft, Preston, United Kingdom
QUALIFICATION BY ANALYSIS - A FRAMEWORK FOR THE FUTURE
Wright, B. D., British Aerospace Defence Ltd., UK; Broome, M. J., British Aerospace Defence Ltd., UK; Future Aerospace Technology in the Service of the Alliance; Dec. 1997; Volume 1; 6p; In English; See also 19980033517; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper provides a framework for exploring ways of reducing the amount of testing required in the process of structural qualification. From a review of the current process, it identifies five areas for particular consideration: structural analysis, design data, loading and environment, the structure, and qualification testing. For each, a brief description of the implications of reduced testing is given together with areas for improvement which are either ongoing or proposed.
Derived from text
Performance Tests; Qualifications; Structural Analysis

19980202247 British Aerospace Public Ltd. Co., Military Aircraft and Aerostructures, Preston, United Kingdom
COST ENGINEERING: A FEATURE BASED APPROACH
Taylor, Ian M., British Aerospace Public Ltd. Co., UK; May 1998; 10p; In English; See also 19980202235; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper will outline British Aerospace's (BAe's) development of Cost Prediction/Management methodologies and toolsets and their relationship to feature based modelling. It will place these developments within the context of the in-house implementation of Integrated Product Definition (IPD) currently being addressed within BAe Military Aircraft & Aerostructure's (MA&A's) requirements for Business Process Re-engineering (BPR) and Operational Efficiency Improvement (OEI). An outline of BAe's commitment to the philosophy and implementation of Integrated Product Development is given in Section 2. Section 3 provides a history of Cost Engineering and it's Design to Cost (DTC) toolset developments. Multi-Disciplinary Optimisation (MDO) as an enabler to efficient Cost Prediction is discussed in Section 4 together with an example of an MDO toolset currently in use within BAe's Airbus Operations Company at Filton. Section 5 introduces Feature Based Costing. How "features" relate to both the design and costing processes is discussed together with an outline of BAe MA&A's development of its "Cost Prediction and Management system" pilot study. Conclusions related to the Cost Prediction process and the importance of "features" are offered in Section 6.
Author
Management Systems; Design to Cost; Parameter Identification; Multidisciplinary Design Optimization; Computer Aided Design; Product Development; Production Costs

19990008074 Advisory Group for Aerospace Research and Development, Flight Vehicle Integration Panel, Neuilly-Sur-Seine, France
STRATEGIC MANAGEMENT OF THE COST PROBLEM OF FUTURE WEAPON SYSTEMS *GESTION STRATEGIQUE DES COUTS DES FUTURS SYSTEMES D'ARMES*
Sep. 1998; 268p; In English; In French; Flight Vehicle Integration Panel Symposium, 22-25 Sep 1997, Drammen, Norway; Sponsored by Advisory Group for Aerospace Research and Development, France; See also 19990008075 through 19990008097; Original contains color illustrations
Report No.(s): AGARD-CP-602; ISBN 92-836-0058-4; Copyright Waived; Avail: CASI; A12, Hardcopy; A03, Microfiche

The Symposium comprised five sessions, each devoted to a particular field: Lessons learned, Overview of current programs, Cost management tools, Low cost manufacturing, and Government perspectives. The Symposium was organized by the Flight Vehicle Integration Panel (FVP) of AGARD and held in Drammen, Norway 22-25 September 1997.
Author
Weapon Systems; Design to Cost; Cost Analysis; Cost Effectiveness; Cost Reduction; Weapons Development; Management Systems; Aircraft Production; Government/Industry Relations; Aircraft Production Costs; Project Management; Defense Industry

19990008075 Lockheed Martin Corp., Skunk Works, Palmdale, CA United States
SKUNK WORKS LESSONS LEARNED
Nicolai, Leland M., Lockheed Martin Corp., USA; Strategic Management of the Cost Problem of Future Weapon Systems; Sep. 1998; 12p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In order to manage a weapon system's cost you must first establish cost as the #1 priority and then incite the program manager and give him the means necessary to hold to the cost. Establishing cost as #l is a company edict and may require a cultural change. The program manager must be a zealot about cost because he will be pressured daily to relax cost in favor of more traditional metrics (i.e., performance, cost effectiveness, signature, etc.). Kelly's 14 Rules gives the program manager the authority and environment necessary to control the cost.
Author
Weapon Systems; Production Costs; Cost Effectiveness; Project Management; Cost Reduction

19990008076 National Defence Headquarters, Project Management Office, Ottawa, Ontario Canada
'COTS': CUSTOMIZATION, OPPORTUNITIES AND TRADE-OFFS
Delaney, R. Grant, National Defence Headquarters, Canada; Sep. 1998; 12p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The aim of this paper is to describe the methods by which the Canadian Armed Forces (CF) balanced a commercial off-the-shelf (COTS) process by customization, opportunities and trade-offs (also COTS) as an example towards meeting the cost challenges of the 21st century. This paper will present a description of the specific customization efforts and associated trade-offs as they apply to the CH146 acquisition and fielding. It will not focus on cost benefit opportunities per se as these issues have been discussed in a previous paper. Some repetition of information will be unavoidable in illustrating opportunities achieved in the CH146 helicopter acquisition and introduction into service. Nor is it intended to discuss the decision making process resulting in the opportunity to acquire a common fleet of helicopters to replace three to four types of aircraft. The comparative arguments should allow the reader to make his or her own conclusion in respect of the ability of this aircraft to meet challenges of the future in your own individual programs.
Derived from text
Helicopters; Cost Effectiveness; Commercialization; Helicopter Design; Systems Integration; Tradeoffs

19990008077 Societe d'Applications Generales d'Electricite et de Mecanique, Argenteuil, France
LESSONS TO BE DRAWN FROM THE CIVILIAN-MILITARY DUALITY: EXAMPLE OF SAGEM COMPANY *LECONS A TIRER DE LA DUALITE CIVIL/MILITAIRE: EXEMPLE DE SAGEM SA*
Remilleux, G., Societe d'Applications Generales d'Electricite et de Mecanique, France; Dupoux, T., Societe d'Applications Generales d'Electricite et de Mecanique, France; Strategic Management of the Cost Problem of Future Weapon Systems; Sep. 1998; 6p; In French; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

SAGEM Company is a dual enterprise within which the manufacturing of military equipment benefits by having an industrial tool base and skills that are shared with civilian activities. An inquiry conducted in these sectors has, however, allowed us to elucidate certain factors which generate excessive cost for military equipment. Analysis of these factors demonstrates that the situation of needs and industrial organizations are greater generators of excessive cost than are the specific constraints of the military.
Transl. by Schreiber
Government/Industry Relations; Production Costs; Production Management; Cost Effectiveness; Cost Analysis

19990008078 Hughes Space and Communications Group, Los Angeles, CA United States
COST MANAGEMENT PROCESSES FOR SATELLITE COMMUNICATIONS SYSTEMS: LESSONS LEARNED
Brackey, Thomas A., Hughes Space and Communications Group, USA; Drennan, Richard M., Hughes Space and Communications Group, USA; Sep. 1998; 6p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A satellite is a spacecraft bus and an integrated payload designed to perform a mission in space. Satellite systems encompass assigned orbital slots, launch support services, a space control segment, and terrestrial communication links for an end-user. Value added data-to-information regimen to fulfill customer demands for specified services is the objective. Satellites are not considered separately from these other segments but complementary to the system. Hughes Space and Communications (HSC) cost-management experience focuses on the satellite because we develop and manufacture satellite systems for domestic and international customers. Currently, 64 Hughes-built commercial satellites are in service in the USA and around the world, with a spacecraft reliability record of better than 99%. We also purchase blocks of launch services from the international launch vehicle community and either own or lease tracking, telemetry, and commanding services and provide technical support for customer operations. These require long-lead procurement to manage cost effectively and to pass these savings on to our government and commercial customers. Cost, schedule, technical performance, and customer focus are the key factors that shape our integrated management strategy with respect to cost management. These are essential to secure and assure our continued success as a viable business. In the USA, government, aerospace, industry, and academia have teamed to sponsor a "lean aerospace manufacturing initiative". The strategy is lean because it does more with less--often much less. It cuts cost and reduces cycle time while improving productivity and quality. The lean aerospace manufacturing industry initiative, with emphasis on the end customer, value streams, customer-forward manufacturing and assembly, leading-edge technology insertion, and quality assurance is exceeding performance projections and reducing mission life cycle costs. Similarly, our cost and management process has significantly increased employee productivity by 47% and reduced costs and cycle times by 30% and is widely emulated within the satellite industry. Therefore, the emphasis of this paper is on the satellite manufacturing enterprise, reduced cycle times, and the changes in business practices and processes needed to satisfy the customers' contractual demands.
Author
Satellite Communication; Communication Networks; Cost Effectiveness; Cost Reduction; Management Systems; Cost Analysis

19990008079 Boeing Commercial Airplane Co., Systems, Seattle, WA United States
THE BOEING 777: A LOOK BACK
Glende, Wolf L., Boeing Commercial Airplane Co., USA; Sep. 1998; 12p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Boeing 777 is the largest twin-engine commercial jet transport in service today. In 1990, approval to proceed with its development was contingent on defining an airplane the airlines would buy at a price Boeing could afford. Innovative processes were developed and implemented that focused on achieving customer preference and reduced program cost. These processes centered on Design Build Teams, Digital Product Definition, and Digital Preassembly. Two years after delivery of the first airplane, the data show that the processes made the 777 the preferred airplane, lowered program costs as predicted, and set new standards and expectations for the development of jet transport aircraft.
Author
Commercial Aircraft; Aircraft Production Costs; Computer Aided Design; Boeing 777 Aircraft; Cost Reduction; Project Management

19990008080 Boeing Co., Philadelphia, PA United States
THE DESIGN AND MANUFACTURE OF AN ALL-DIGITAL V-22
Dougherty, J. J., III, Boeing Co., USA; Liiva, J., Boeing Co., USA; Sep. 1998; 8p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The production V-22 has incorporated the latest technologies and computer-aided techniques and manufacturing processes. These are: (1) CATIA(TM) (Computer-Aided Three-Dimensional Interactive Application) for design. A single authority digital data base that contains all the design information; (2) Digital electronic mockup (EMU) to determine part fit-up and resolve interface problems during the design phase through Digital Pre-Assembly (DPA), instead of creating panic on the assembly line; (3) Concurrent Product Development using over 80 Integrated Product Teams (IPTs) consisting of engineering, tooling, manufacturing, supportability and subcontractor disciplines, working simultaneously on each major part of the aircraft to ensure a "balanced" design. The multiple customers for the V-22 aircraft, USMC, USN, and USAF/SOCOM, are an integral part of the IPTs. An Analysis and Integration (A&I) team ensures consistency across interfaces and an Integrated Test Team (ITT) of contractor and customer personnel perform flight testing; and (4) Manufacturing process improvements including the utilization of part features to

locate and assemble components; fiber placement of large pieces of composite structure with simple and compound curvature; high speed machining of large monolithic pieces of metallic structure rather than assembling them from pieces; laser optical layout templates driven from the CATIA(TM) data base to locate composite plies during lay-up; robotic trim and drill cells; automated creation of wiring form boards and numerically controlled, CATIA(TM) data base to locate composite plies during lay-up; robotic trim driven, automatic bending of hydraulic tubes. The results of using these new technologies and processes are compared with 1980's methods.
Author
Computer Aided Manufacturing; Computer Aided Design; V-22 Aircraft; Concurrent Engineering; Aircraft Production Costs; Cost Effectiveness

19990008081 Thomson-CSF, Radars et Contremesures, Elancourt, France
THOMSON-CSF EXPERIENCE IN AIRBORNE SYSTEM INTEGRATION
Monclar, Patrick, Thomson-CSF, France; Sep. 1998; 18p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The strategic management of the cost issue is of major importance for any company; basically, the question is to combine the customers' satisfaction and the company's profitability. The customers' satisfaction is met with agreeable and affordable levels of price and performance of the products and systems they buy. The company's profitability is needed to meet the basic rules of capital and strategic investment. In our so called "high tech" companies we have also to take account of the huge level of R and D required to run our projects and programs. More and more, this R and D is partially, if not totally, self-funded by the company itself. Furthermore, cost management must enable us to get the resources which are needed to be in the position to study, then develop and produce the future systems which will be in the Forces, our customers. Many answers can be given to this difficult question of cost management. After having introduced my company, THOMSON-CSF/Radars et Contremesures (RCM), and our main airborne systems, I will address our global methodology dedicated to these systems' studies and developments. This methodology, without any doubt, is the fundamental core of our know-how, not only relying on more or less heavy and sophisticated tools, but also and above all fed by the unique skill of our staff, for decades. Charts outlining RCM and its products and systems overview are presented.
Author
Cost Effectiveness; Cost Reduction; Systems Integration; Research and Development; Systems Engineering; Aircraft Production Costs; Aircraft Design

19990008082 Aermacchi S.p.A., Engineering Dept., Venegono Superiore, Italy
THE AERMACCHI YAK/AEM-130 AND AT-2000 DESIGN OBJECTIVES: A TOPIC IN THE SUBSONIC VERSUS SUPERSONIC TRAINING TRADE-OFF
Lucchesini, Massimo, Aermacchi S.p.A., Italy; Iaia, Pierclaudio, Aermacchi S.p.A., Italy; Sep. 1998; 12p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A modern trainer should be designed in accordance with the needs imposed by the entry into service of new and more capable operational aircraft. The trainers currently in service were designed, at best, with late 60's generation fighters in mind. The introduction of a modern trainer into service will allow substantial savings, over their life-cycle, with respect to the existing advanced trainers, even if updated with state-of-the-art avionic systems. This paper deals with the cost-effectiveness of selecting a subsonic or a supersonic configuration as a baseline. The result of a quantitative evaluation, carried on a representative training scenario, shows that the higher costs of a supersonic configuration will not be paid by the reduction in training costs, and that the optimal baseline is still a subsonic trainer, designed to be representative as much as possible of the modern combat aircraft.
Author
Training Simulators; Cost Effectiveness; Cost Reduction; Pilot Training; Training Analysis

19990008083 Department of Defense, Advanced Cost Estimating Team, Arlington, VA United States
JOINT STRIKE FIGHTER: COST MODELING IN THE JSF
Younossi, Obaid, Department of Defense, USA; Sep. 1998; 10p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

This paper is about the Joint Common Cost Model(JCCM), a cost model developed to meet the unique challenges of estimating the cost of the Joint Strike Fighter Program. The cost model was developed to estimate the cost of a family of aircraft with maximum design and manufacturing commonality which meets the requirements of the USA Navy, Air Force, Marine Corps as well as the UK's Royal Navy. The JCCM incorporates the effect of commonality among different Service variants, the cost of advanced material composition, the cost of low observability, the costs of a robust avionics suite, the costs of a propulsion system capable of conventional flight and short take off and landing, and the cost effects of affordability initiatives in the area of Producibilty and Manufacturing. to our knowledge a model that meets these difficult requirements had not previously been developed.
Author
Fighter Aircraft; Aircraft Production Costs; Systems Integration; Cost Analysis; Mathematical Models; Cost Estimates; Project Management

19990008084 Kongsberg Gruppen ASA, Kongsberg, Norway
SIMEN: AN IN-HOUSE SIMULATION TOOL, REDUCING RISK AND COST FOR THE NSM DEVELOPMENT PROGRAM
Drogset, Gunn Helene, Kongsberg Gruppen ASA, Norway; Sep. 1998; 4p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

This paper describes the simulation tool (SIMEN) developed to support a cost-effective and low-risk development of the new anti-ship missile (NSM) for the Royal Norwegian Navy (RNoN). Missile test firings are very expensive, difficult to plan and predict, and they seldom cover all test scenarios. Therefore, computer simulations in our missile programs have become more and more important as powerful computers and SW tools are getting more cost-effective. Powerful visualizations of simulations make SIMEN a useful tool for everybody working with NSM. One of the main goals with the use of SIMEN is to help the project detect errors in the missile system as early as possible to minimize the costs and technical risks.
Author
Missile Systems; Computerized Simulation; Missile Design; Mathematical Models; Computer Programs; Computer Aided Design

19990008085 Daimler-Benz Aerospace A.G., Military Aircraft Div., Munich, Germany
PARAMETRICS AS AN ADEQUATE COST ESTIMATION TOOL FOR AFFORDABLE HIGH-TECH PRODUCTS
Wenzel, Meinolf, Daimler-Benz Aerospace A.G., Germany; Strategic Management of the Cost Problem of Future Weapon Systems; Sep. 1998; 26p; In English; See also 19990008074; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

It is my understanding that this panel of AGARD deals with highly sophisticated technical matters, extending the edge of technology into the unknown and satisfying the human mind in so far as it gives a better understanding of physics and nature and hopefully has very practical consequences for applications. My subject deals with the affordability of such applications. This means an understanding of nature as well but it is the human nature and human behavior in engineering groups and program teams consequences that matter if we want to understand the ultimate cost drivers that are the key elements of cost origination.
Derived from text
Cost Estimates; Computer Aided Design; Design Analysis; Computer Programs; Cost Analysis; Parameter Identification; Computerized Simulation

19990008086 Kongsberg Defence and Aerospace A/S, Kongsberg, Norway
THE IPF PROJECT: CONCURRENT ENGINEERING EFFORTS AT KONGSBERG DEFENCE AND AEROSPACE
Andersen, P., Kongsberg Defence and Aerospace A/S, Norway; Sep. 1998; 12p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes Kongsberg Defence & Aerospace's (KDA) work in the implementation of Concurrent Engineering (CE) practices. The work has been done through an internal improvement project, IPF. The paper provides information about background, methods, tools, supporting techniques, verification examples and results. It documents results showing that adaptation of the CE practices can lead to a tremendous savings in project cost and time.
Author
Concurrent Engineering; Cost Effectiveness; Project Management

19990008087 Det Norske Veritas, Hovik, Norway
CMT: AN INNOVATIVE SYSTEM FOR PROJECT RISK MANAGEMENT
Pedersen, F. B., Det Norske Veritas, Norway; Tomte, E., Norwegian Air Material Command, Norway; Sep. 1998; 10p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A risk management system called Criticality Management Tools (CMT) /1/ is introduced. This system (procedures and software tools) supports a preventive and proactive approach, which enables early identification of hazards and risk affecting the project objectives. The hazards may originate from a broad range of disciplines, such as economy, politics, technology, environment, etc. An information management module contains the resources needed to perform risk monitoring and controls experience data collected from surveys and pilot projects. These data will be continuously updated with experience gained through the use of CMT in ordinary projects.
Author
Project Management; Information Management; Management Systems; Risk

19990008088 Alenia Aeronautica, Turin, Italy
PAST AND FUTURE PROGRAMMES: A VIEW ON COST MANAGEMENT EVOLUTION AND CHALLENGES
Lojacono, E., Alenia Aeronautica, Italy; Mazzetti, B., Alenia Aeronautica, Italy; Sep. 1998; 8p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The challenge of meeting the requirements for an effective air combat capability in the future, constrained by ever more demanding budgetary limitations, must be faced in the broadest possible terms to identify the affordable solutions. Cost analysis of a weapon system must consider the entire life cycle of the system, from initial concept and realization of the first series through the variants which scenario requirements and technological evolution impose on the system to maintain an operational capacity which meets the demands of intended use. The cost of a program in its entirety, i.e. the Life Cycle Cost (LCC), is essentially determined by the physical parameters of the system produced and the process by which it is realized and managed: it is of course true to say that developments both in the recent past and currently in evolution have led to techniques and procedures which aim to reduce such effects to a minimum. However, in general terms, the level of cost is determined by factors of a general nature which reflect the system requirements and the contractual framework within which it is developed, acquired and managed during its lifetime. Experience gained in various programs operative during these years in which cost management techniques have been identified and to a certain extent put into practice, suggests the need to cross-analyze such elements of cost control: in a similar way to the constraints of requirements and contractual typologies they can condition the effectiveness of the techniques and procedures of cost management.
Author
Financial Management; Management Methods; Cost Analysis; Project Management

19990008089 Ministry of Defence, Abbey Wood, United Kingdom
COST EFFECTIVENESS IN UK DEFENCE PROCUREMENT: THE COEIA
Lindop, A. J., Ministry of Defence, UK; Sep. 1998; 20p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The UK has recently adopted a process for obtaining the most cost effective equipment for its armed forces, known as the Combined Operational Effectiveness and Investment Appraisal (COEIA). The role that the COEIA fulfills in the current UK defense procurement practice is explained and compared with previous practices. An outline of the process of selecting a Class of Military equipment by means of a Balance of Investment study is followed by a description of how to select the most cost effective Type of Equipment within a class using a combination of investment appraisal and estimating the military effectiveness of the equipment. The investment appraisal process for an aircraft system is described in terms of selecting the alternative procurement options, defining the assumptions, examining the cost breakdown structure, discounting the expected cash flow and analyzing the risks and uncertainties. The different mechanisms for measuring operational effectiveness are examined in order to explore the military benefit which is expected from the alternative options. In conclusion, alternative ways of combining cost and effectiveness are illustrated graphically to show how the most cost effective option for the procurement could be derived.
Author
Cost Effectiveness; Cost Analysis; Government Procurement; Equipment Specifications; Financial Management

19990008090 British Aerospace Public Ltd. Co., Preston, United Kingdom
THE FUTURE FOR COMBAT AIRCRAFT DESIGN: AN INDUSTRIAL VIEW
Skorczewski, L., British Aerospace Public Ltd. Co., UK; Sep. 1998; 4p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A01, Hardcopy; A03, Microfiche

The paper addresses the design and technology drivers which are likely to have the most impact on the next generation of combat aircraft from an industrial perspective. The nature of future conflicts and the emerging threats are becoming increasingly difficult to predict, and operational needs stress the growing importance of flexibility and survivability to meet these indefinable future scenarios. The inescapable fact is that market forces are no longer able to support "performance at any cost" because defense budgets worldwide are being reduced and there is increasing competition for fewer orders. The key attribute of any future combat aircraft is now AFFORDABILITY, and the technology and design drivers which find their way into new combat aircraft will be those which provide major life cycle cost savings, whilst meeting adequate performance margins. The processes and mechanisms associated with achievement of major cost savings are discussed as a means of industrial survival in an increasingly competitive and uncertain world.
Author
Aircraft Design; Aircraft Production Costs; Cost Reduction

19990008091 British Aerospace Public Ltd. Co., Blackburn, United Kingdom
AGILE MANUFACTURING: MYTHOLOGY OR METHODOLOGY?
Eastham, J., British Aerospace Public Ltd. Co., UK; Sep. 1998; 10p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The 'lean manufacturing' concept is well known and its application through the use of principles such as Pareto analysis, Kanban, JIT and WIP (etc) has the potential to realize significant cost benefits. There is, however, a potential down side to the 'lean and mean' environment; a reduced ability to respond to change. The need for a level of flexibility in the overall manufacturing process has therefore been recognized. Flexibility can be planned into the process at an early stage, perhaps as an intrinsic part of a risk management exercise for example, but such processes tend to be flexible only within the pre-set boundaries. In practice, however, the operational environment may be subject to a wide range of intrinsic and extrinsic variability which cannot be accounted for during the planning stage. More recently a new concept has begun to emerge which seeks to address the above issue; Agile Manufacture. The concept remains somewhat vaguely specified at present and has been variously interpreted as synonymous with 'flexibility', 'responsiveness' and even 'lean'. Alternatively Agile Manufacture may be seen as a new approach to production which encompasses flexible engineering methods and operations management. This paper addresses the agile concept from a manufacturing viewpoint and seeks to understand if agility is in fact a 'paradigm' or merely new coinage for an old currency.
Author
Engineering Management; Manufacturing; Flexibility; Cost Effectiveness; Production Management

19990008092 Aerospatiale Missiles, Service Genie Systeme et Logiciel, Chatillon, France
COST CONTROL IN THE DEVELOPMENT OF SYSTEMS AND THEIR SOFTWARE ***LA MAITRISE DES COUTS DANS LE DEVELOPPEMENT DES SYSTEMES ET DE LEURS LOGICIELS***
Padel, P., Aerospatiale Missiles, France; Sep. 1998; 8p; In French; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Being both a systems developer and missile builder, Aerospatiale Missiles deals with systems that include a high proportion of software. Depending upon the type of product (integrated systems for command, fire control units, missiles, associated equipment), the software portion is generally greater than that of the hardware. The definition of a system results from studies which allow one to identify and characterize the function and architecture (technical solutions). These technical solutions are the resul of technological choices that can result from arbitration among all of the software and all of the hardware, or of intermediate blended solution. The forecasted cost of software is highly dependent on the choices that are made and therefore cannot be independent from that of the the rest of the system.
Transl. by Schreiber
Financial Management; Cost Effectiveness; Computer Systems Design; Software Engineering; Computer Programs; Systems Integration

19990008093 Boeing Co., Saint Louis, MO United States
THE VALUE OF S AND T IN AFFORDABILITY
Lang, J. D., Boeing Co., USA; Birchfield, B., Boeing Co., USA; Saff, C. R., Boeing Co., USA; Shumaker, G., Air Force Research Lab., USA; Sep. 1998; 18p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Science and Technology (S&T) programs can have critical impact on the cost of aeronautical systems. The problem is to teach S&T personnel how to deal with the impact that their technologies have on cost as well as they deal with the technical performance impacts. The U.S. government focus on affordability in defense system procurement has provided a timely opportunity for initiatives to be developed and put in place. This paper discusses some of those government initiatives and some of those found in industry. Results are presented. The benefit of addressing four areas concurrently will be discussed. They are: Culture change, including the use of Integrated Product and Process Development (IPPD) and Integrated Product Teams (IPT), use of appropriate metrics, emphasis on transition of technologies to acquisition programs, and timely education and training.
Author
Research and Development; Product Development; Procurement; Cost Effectiveness; Government/Industry Relations; Education

19990008094 Department of Defense, Joint Strike Fighter Program Office, Arlington, VA United States
TECHNOLOGY: SOLUTION FOR THE NEXT GENERATION OF AFFORDABLE STRIKE FIGHTERS
Schwartz, Frederic C., Department of Defense, USA; Sep. 1998; 8p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

An essential element of the Joint Strike Fighter Program is the specific application of technologies to significantly reduce the life cycle cost of the weapon system. The strategy is to aggressively attack those attributes and features, which are high cost drivers for a strike fighter weapon system through various innovative approaches. The Joint Strike Fighter Program has addressed this by: 1) Identifying those specific features and characteristics which are high cost drivers so that one can apply scarce resources to the most leveraging attributes; 2) applying the Strategy-to-Task-to-Technology methodology and Quality, Function and Deployment(QFD) analysis to logically prioritize investment strategies; 3) identifying and leveraging opportunities for common technology demonstrations which apply to multiple weapon system concepts; and 4) coordinating activities across the various Science and Technology(S&T) communities to target significant life cycle cost drivers for strike fighter platforms.
Author
Weapons Development; Research and Development; Life Cycle Costs; Aircraft Production Costs; Fighter Aircraft

19990008095 Delegation Generale de l'Armement, Paris, France
REORGANIZATION OF THE GENERAL WEAPONS DIRECTORATE (DGS) IN FRANCE ***LA REORGANISATION DE LA DELEGATION GENERALE POUR L'ARMEMENT (DGA) EN FRANCE***
Salomon, Arnaud, Delegation Generale de l'Armement, France; Sep. 1998; 12p; In French; See also 19990008074; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

As was mentioned in the general presentation, one of the goals of our symposium is to examine government prospects with respect to management of programs in order to achieve realistic cost, or to allow common adoption of better practices in order to take up the challenge of costs. The text which follows is not a comprehensive or official presentation of the new General Directorate for Weapons (DGA) in France. On the contrary, it reflects, in the same spirit of our symposium, an analysis by one member of the FVP committee which works with DGA, regarding the advantages which the French department gains after or during its reorganization. Without attempting to be comprehensive here, we will only deal with advances which are directly related to the theme of the symposium.
Transl. by Schreiber
Government/Industry Relations; Financial Management; Cost Effectiveness; Engineering Management; Organizing; Weapons Development

19990008096 Defence Evaluation Research Agency, Rotary Wing Aircraft Dept., Boscombe Down, United Kingdom
REORGANISATION OF EVALUATION AND RESEARCH TO SUPPORT FUTURE DEFENCE PROCUREMENT
Cadwallader, R., Defence Evaluation Research Agency, UK; Sep. 1998; 8p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In response to the changing defense environment and political and economic pressures, UK non-nuclear defense science and technology capability has been drawn together as the Defense Evaluation and Research Agency (DERA). The agency remains a government organization but operates as a trading agency supplying its services to customers (principally in the UK MoD) on a full cost basis, and required to demonstrate best commercial practices and financial viability. This paper traces the early days as the Defence Research Agency (DRA) through to its current structure, highlighting some of the challenges along the way, and sets out some future initiatives to maintain its position.
Author
Organizations; Government/Industry Relations; Organizing; Defense Industry; Cost Effectiveness

19990008097 Naval Air Warfare Center, Aircraft Div., Patuxent River, MD United States
COST REDUCTION STRATEGIES IN ACQUIRING AIRCRAFT WEAPON SYSTEMS AT "PAX RIVER"
Zalesak, Philip F., Naval Air Warfare Center, USA; Sep. 1998; 10p; In English; See also 19990008074; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The most significant consolidation in the U.S. Department of Defense (DoD) just occurred at the Naval Air Station in Patuxent River, Maryland. This air station is commonly referred to as "Pax River". The U.S. Navy collocated its aircraft program managers, developers, testers, procurement, and logistics personnel at Pax River to achieve greater efficiency and effectiveness in buying aircraft weapon

systems. The purpose of this paper is to discuss this consolidation and the tremendous research, development, test and evaluation (RDT&E) capability now resident at this site.
Author
Defense Program; Consolidation; Cost Reduction; Research and Development; Government Procurement; Navy; Weapons Development

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DOCUMENTATION AND INFORMATION SCIENCE

19950019914 Advisory Group for Aerospace Research and Development, Technical Information Panel, Neuilly-Sur-Seine, France
DIRECTORY OF DEFENCE AND AEROSPACE INFORMATION CENTERS *ANNUAIRE DES CENTRES DE LA DEFENSE ET DE L'AEROSPATIALE CIVILE*
Mar 1, 1995; 101p; In English
Report No.(s): AGARD-R-802; AD-A293980; ISBN 92-836-1015-6; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

The Directory of Defense and Aerospace Information Centers is a reference guide to information centers located in NATO nations. The information provided represents submissions from forty eight information centers across fourteen countries. The guide provides assistance in locating scientific and technical information resources from several countries' information centers. Points of contact are provided for each center. The directory includes information on: points of contact, subject coverage, description of major products and services, access limitations where applicable, e-mail addresses, and phone and fax numbers. An index to centers by organizational title is included for quick reference.
Author
Directories; Information Systems; Libraries; North Atlantic Treaty Organization (NATO)

19950026777 Advisory Group for Aerospace Research and Development, Technical Information Panel, Neuilly-Sur-Seine, France
INDEX OF AGARD PUBLICATIONS: 1992-1994 *AGARD INDEX DES PUBLICATIONS 1992-1994*
Jul 1, 1995; 503p; In English
Report No.(s): AGARD-INDEX-92-94; ISBN 92-836-1019-9; Copyright Waived; Avail: CASI; A22, Hardcopy; A04, Microfiche

This volume provides abstracts and indexes for AGARD unclassified publications published during the period 1992-1994. Full bibliographical citations and abstracts for all the documents in this publication are given in the abstract section, which is organized in the major subject divisions and specific categories used by NASA in abstract journals and bibliographies. The major subject divisions are listed, together with a note for each that defines its scope and provides any cross-references. Category breaks in the abstract section are identified by category number and title, and a scope note. Within each category, the abstracts are arranged by series and year. Six indexes - Subject (based on NASA Thesaurus nomenclature), Personal Author, Corporate Source, Panel, Report/Accession Number, and Accession Number - are included. Sample entries are shown on the first page of each index. This publication was sponsored by the Technical Information Committee of AGARD (TIC), and compiled by NASA's Center for AeroSpace Information (CASI).
Author
Aeronautics; Aerospace Engineering; Indexes (Documentation); North Atlantic Treaty Organization (NATO)

19960007294 Advisory Group for Aerospace Research and Development, Technical Information Panel, Neuilly-Sur-Seine, France
GUIDE TO MULTIMEDIA STORAGE *LE GUIDE DES MEMOIRES MULTIMEDIA*
Sep 1, 1995; 92p; In English
Report No.(s): AGARD-AR-341; NIPS-95-06086; ISBN 92-836-1024-5; Avail: CASI; A05, Hardcopy; A01, Microfiche

The guide to multimedia is a review of the current storage devices available for accessing, retrieving, and storing information. The discussion addresses the principal devices available. A selected bibliography is provided as a reference tool for further inquiry. The type of multimedia devices used in an information storage and retrieval environment will vary with the size of the collection, the demand for information, and the retrieval capability required. While there are several methods of storage available, ease of access, cost, reading and writing capabilities, and durability are a few of the issues that should be addressed in determining the needs of an information center. This guide provides information on twelve major storage devices. A description is provided on their benefits, limitations, durability, platform capabilities, comparison, storage capacity, physical characteristics, data capacity, ease of use, copying capability, cataloguing rules and data standards. There are three major groupings to this guide. The first is optical storage capability. CD-ROM, optical disk, and photo CD are reviewed. The second is magnetic storage. This grouping includes magnetic tape, video tape, tape cassette and cartridge, floppy disk, hard disk, and removable storage systems. The third grouping is defined as other media storage. Photo media, audio material and motion picture comprise this group. Regardless of the storage device used, the key is effective management to enable immediate access to information when required.
Author
Data Acquisition; Data Storage; Information Management; Information Retrieval; Magnetic Storage; Multimedia; Optical Memory (Data Storage)

19960016905 Mitre Corp., Bedford, MA United States
AN INTEGRATED THEATER BATTLE MANAGEMENT C2 ARCHITECTURE BASED ON COMMERCIALLY AVAILABLE SOFTWARE
Green, Edwin J., Mitre Corp., USA; Krutsch, Michael C., Mitre Corp., USA; Oct. 1995; 10p; In English; See also 19960016897; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

For the past two decades, 'stove-pipe' Command and Control (C2) information systems have proliferated within the Department of Defense (SOS). This proliferation has resulted in duplication of development effort, systems which are not interoperable, and large lifecycle costs. to a large extent, these systems have been built with uniquely developed software. Much of this unique software constitutes what is commonly referred to as the software infrastructure (e.g., system level services and support services for mission application software). For Theater Battle Management (TBM) C2 information systems, the software infrastructures are inherently the same with regard to the functions and services they provide. Technically, these systems could benefit from a common software infrastructure. With advances in the commerical software market, the realization of such a common infrastructure no longer needs to rely on uniquely-developed software. The commercial marketplace provides solutions for significant portions of the software infrastructure based on open systems standards and mature standards-based products.
Derived from text
Computer Systems Design; Systems Integration; Architecture (Computers); Applications Programs (Computers); Management Information Systems; Computer Systems Programs; Command and Control; Warning Systems; Defense Program; Management Methods

19970012593 Science Applications International Corp., Arlington, VA United States
BENCHMARKING ATR TEST DATA
Hauter, Andrew, Science Applications International Corp., USA; Diehl, Vince, Science Applications International Corp., USA; Williams, Arnold, Science Applications International Corp., USA; Orsak, Geoffrey, George Mason Univ., USA; Sorell, Matthew, George Mason Univ., USA; Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications; Oct. 1996, 187-202; In English; See also 19970012579
Contract(s)/Grant(s): F33615-91-C-1801; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

By means of statistical considerations it is possible to derive a classification rule which is optimal in the sense that, on an average basis, its use yields the lowest probability of committing classification errors. This statistically optimal classification rule is a generally accepted standard against which the performance of other classification algorithms are often compared. As is true in many fields which deal with measuring and interpreting physical events, statistical considerations become central in Automatic Target Recognition because of the randomness under which classes are distributed in sensory data. There has been considerable investment in real time Automatic Target Recognition Systems that employ multiple-sensor and multiple-look evidence accumulation strategies. These ATR's exploit predetermined models of the targets and target states using correlation

matching processes to declare targets or target features and various detector forms and graph matching techniques to accumulate evidence. Due to the nature of the sensors and environment, it is not clear that these algorithms can be cast in an optimal fashion; however, given a selected training and test set much can be said about the respective performance. It is this benchmark by which this paper measures performance. to this end, techniques for estimating the probability of errors inherent in the sampled data sets and the calculations of bounds on this measured performance are investigated.
Derived from text
Target Recognition; Probability Theory; Sampled Data Systems; Algorithms

19970029367 Thomson-CSF, Branche Equipments Aeronautiques, Malakoff, France
NEW SOURCES OF GEOGRAPHIC DATA TO AID IN AIR-GROUND IDENTIFICATION *NOUVELLES SOURCES DE DONNEES GEOGRAPHIQUES POUR L'AIDE A L'IDENTIFICATION AIR-SOL*
dePeufeilhoux, Renaud, Thomson-CSF, France; Cazeneuve, Helene, Thomson-CSF, France; Hervy, Philippe, Thomson-CSF, France; Jul. 1997; 11p; In French; See also 19970029347; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Geographic data were used very early on for cruise missiles and long-range operational aircraft in connection with navigation functions, such as navigation readjustment and very-low-altitude navigation. Two types of data were used for navigation readjustment: relief data (DEM: digital elevation model) or topographic data (landmarks or seamarks); for very low-altitude navigation: essentially relief data. The development of observation satellites starting in the seventies made it possible rather quickly to assemble big relief databases; the preparation of the MNT (numerical terrain model), from a stereocouple, is largely automatic and thus needs little operator action; on the other hand, one may think that, when it comes to Large surfaces, relief constitutes information that is rather stable in terms of time so that it can be prepared rather far in advance, contrary to planimetric data (cultural features) that are of a more ephemeral nature.
Author
Satellite Observation; Air Navigation; Cruise Missiles; Mathematical Models; Topography

19980019877 Advisory Group for Aerospace Research and Development, Technical Information Panel, Neuilly-Sur-Seine, France
AN INTERNATIONAL AEROSPACE INFORMATION NETWORK: IAIN *FINAL REPORT*
Feb. 1998; 30p; In English
Report No.(s): AGARD-AR-366; ISBN 92-836-1070-9; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

Reports the outcome of the deliberations of a Working Group set up by the Technical Information Committee of AGARD to examine the models of existing cooperative international databases and make recommendations for the establishment of such a database to serve the aerospace sector. The report recommends the Internet as the most suitable vehicle for this and describes a prototype International Aerospace Information Network (IAK Homepage which was developed by the Group for use as a Proof of Concept. In this prototype Homepage, which is intended to be a limited version of the finished network, several connections have been made to information sources as a demonstration of the concept and the capability that would be inherent in the final stage. It is stated that in order to deliver the desired data and information and needed services to the user, the network should include: the ability to search for aerospace and aerospace-related data and information across heterogeneous systems aerospace and aerospace-related data directory information the facility to order data products through a simplified 'one-stop shopping' procedure the delivery of data to users on a variety of standard media, including electronic delivery where appropriate.
Author
Information Systems; Internets; Data Bases

19980210651 Hollandse Signaalapparaten N.V., Applied Systems Research Dept., Hengelo, Netherlands
TA10: ADVANCED INFORMATION PROCESSING FOR MULTI-SENSORY SYSTEMS. IEPG COOPERATIVE TECHNOLOGICAL PROGRAMS: TECHNOLOGICAL AREA 10
deLeeuw, Charles, Hollandse Signaalapparaten N.V., Netherlands; Chalmeton, Vincent, Thomson-CSF, France; Multi-Sensor Systems and Data Fusion for Telecommunications, Remote Sensing and Radar; Apr. 1998; 12p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Real-time interpretation of large amounts of battlefield information by both operator and system is increasingly difficult due to steadily growing complexity, and integration of systems. Therefore data fusion, i.e. combining data from several sources in order to obtain a global and coherent view on the battlefield, both at sensor level (multi sensor data fusion) and at abstract, strategic information level (information fusion), becomes more important. In this paper we will describe the different concepts used for the multi sensor data fusion processes, and the distributed asynchronous software architecture chosen. Furthermore, the interaction between Data Fusion, Situation Assessment and Sensor/Platform Management will be explained in order to Sensors/Platforms illustrate the applied technologies for advanced information processing for multisensory systems. In the paper some of the first results from this on-going project will be presented.
Author (revised)
Real Time Operation; Warfare; Information Systems; Data Flow Analysis

19980210652 British Aerospace Public Ltd. Co., Military Aircraft and Aerostructures, Lancashire, United Kingdom
AIRCRAFT SENSOR DATA FUSION: AN IMPROVED PROCESS AND THE IMPACT OF ESM ENHANCEMENTS
Noonan, C. A., British Aerospace Public Ltd. Co., UK; Pywell, M., British Aerospace Public Ltd. Co., UK; Multi-Sensor Systems and Data Fusion for Telecommunications, Remote Sensing and Radar; Apr. 1998; 10p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

British Aerospace Military Aircraft and Aerostructures (BAe MA&A) has conducted various studies on the topic of Data Fusion. This paper highlights developments which, it is thought, offer a significant step towards optimum situation awareness. It examines sensor data quality, the fusion process and method function. The paper also examines the key issues affecting quality of track data fed into the fusion process by Electronic Support Measures systems (ESM), the prime threat identity data. Emitter recognition and location issues are discussed and potential routes are proposed to attain the necessary performance increases to support optimum situation However, lack of adherence to a known plan is not a conclusive awareness.
Author
Multisensor Fusion; Emitters; Remote Sensing; Aircraft Production

19980210656 Royal Military Academy, Signal and Image Centre, Brussels, Belgium
DATA FUSION FOR LONG RANGE TARGET ACQUISITION
Verlinde, Patrick, Royal Military Academy, Belgium; Borghys, Dirk, Royal Military Academy, Belgium; Perneel, Christiaan, Royal Military Academy, Belgium; Acheroy, Marc, Royal Military Academy, Belgium; Apr. 1998; 10p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

An approach to the long range automatic detection of vehicles, using multi-sensor image sequences is presented. The algorithm we use was tested on a database of six sequences, acquired under diverse operational conditions. The vehicles in the sequences can be either moving or stationary. The sensors are stationary, but can perform a pan/tilt operation. The presented paradigm uses data fusion methods at four different levels (feature level, sensor level, temporal level and decision level) and consists of two parts. The first part detects targets in individual images using a semi-supervised approach. For each type of sensor a training image is chosen. On this training image the target position is indicated. Textural features are calculated at each pixel of this image. Feature level fusion is used to combine the different features in order to find an optimal discrimination between target and non-target pixels for this training image. Because the features are closely linked to the physical properties of the sensors, the same combination of features also gives good results on the test images, which are formed of the remainder of the database sequences. by applying feature level fusion, a new image is create in which the local maxima correspond to probable target positions. These images coming from the different sensors are then combined in a multi-sensor image using sensor fusion. The local maxima in this multi-sensor image are detected using morphological operators. Any available prior knowledge about possible target size and aspect ratio is incorporated

using a fusion (also called score or measurement level fusion), medium region growing procedure around the local maxima. A variation to this approach, that will also be developed in this paper, combines the previous feature and sensor level fusion, by extracting the features in each sensor as before but using the from all sensors in what is sometimes called a <super feature vector>>. Tracking is used in both cases to reduce the false alarm rate.
Author
Multisensor Applications; Warfare; Target Acquisition; Multisensor Fusion; Morphology

19980210663 Forschungsinstitut fuer Informationsverarbeitung und Mustererkennung, Ettlingen, Germany
MULTISENSOR DATA FUSION FOR AUTOMATIC RECOGNITION OF HIGH VALUE SURFACE TARGETS
Bers, K.-H., Forschungsinstitut fuer Informationsverarbeitung und Mustererkennung, Germany; Essen, H., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Jaeger, K., Forschungsinstitut fuer Informationsverarbeitung und Mustererkennung, Germany; Schimpf, H., Forschungsinstitut fuer Hochfrequenzphysik, Germany; Apr. 1998; 8p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes a system for surveillance and target recognition for autonomous stand-off weapons based on the interpretation of multisensor data in combining the individual sensor channels to optimize the system performance by intelligent fusion techniques. to meet this demand, we propose a model-based method for the automatic recognition of high value fixed or relocatable surface targets like bridges, airfields, industrial installations and command posts. A production net is used to represent the knowledge about target structures. The analysis is carried out by a knowledge based classification system. Starting with primitive objects extracted separately from each individual sensor channel (low-level-processing), more complex parts are composed step by step until the target object is recognized (high-level-processing). The radar preprocessing comprises a thresholding prescreener and a subsequent feature based discrimination stage, the features making use of polarimetric and geometric properties, and of scattering center statistics. The IR-preprocessing is more related to geometric and structural features like line elements, corners and circles. to enhance the detection probability, in the low level stage a high false alarm rate is accepted as regards the primitive objects. The reduction of the false alarm rate is done in the high level stage by the spatial fusion of 2D- or 3D-structures and by using additional context information of the target environment. The purpose of this paper is to address the state of the algorithms for automatic recognition of high value surface targets. For this, sensor data have been interpreted which were recorded with an imaging infrared sensor and a coherent, polarimetric, high range resolution radar. to enable the spatial fusion process, the raw sensor data were registered together with inertial data of the aircraft. The efficiency of the analysis system is demonstrated by an example involving the detection of command posts. The results show the suitability of the method for future autonomous stand-off weapon systems like drones and missiles with imaging sensors.
Author
Multisensor Fusion; Multisensor Applications; Autonomy; Target Recognition; Surveillance; Weapon Systems; Infrared Detectors; Detection

19980210674 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
USE OF CONTEXTUAL INFORMATION IN MULTIPLE SENSOR TRACKING *UTILISATION D'INFORMATIONS CONTEXTUELLES DANS DES ALGORITHMES DE PISTAGE MULTICAPTEUR*
Nimier, Vincent, Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1998; 13p; In French; See also 19980210650; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this article we propose a method which allows one to combine symbolic data with numerical data. In order to do this, we propose a process of estimation controlled by a context analysis level. The application anticipated is the merging of data and the algorithms which are inserted in the multiple sensor systems. These algorithms must be designed so that the system will function in a nominal way under all conditions. In order to achieve this, the system must be capable of adjusting, so that at any moment the evaluation will take into account the context in question. The result will be to make available, in certain contexts, the measurements coming from the sensors in nominal condition of functioning and of reducing the importance of the ones which are aberrational in light of certain criteria which are established in advance by an expert.
Author
Numerical Analysis; On-Line Systems

19980210675 MATRA Systemes and Information, Direction des Filieres Technologiques, Val de Reuil, France
SAGESSE: A MODEL OF DATA REPRESENTATION FOR THE MERGING OF SYMBOLIC DATA *SAGESSE: UN MODELE DE REPRESENTATION DE DONNEESPOUR LA FUSION DE DONNEES SYMBOLIQUES*
Pollet, Yann, MATRA Systemes and Information, France; Robidou, Sebastien, MATRA Systemes and Information, France; Apr. 1998; 11p; In French; See also 19980210650; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A system of symbolic data merging has the goal of developing and processing at any moment the most complete, exact and coherent possible image of an external world during its evolution, called the situation, from uncertain, incomplete and imprecise input data. The modeling of a situation requires representation of the concept of imprecision on the characteristics of the perceived objects, the idea of doubt as to the existence of an object, but also the representation of the hypothetical information used during the reasoning. We present in this report a formal approach which allows one to integrate in a unified way these different ideas in a single representational model, providing them with a precise semantic base. We then describe the application for this approach and the pilot implementation which was carried out under the international program DFD (Data Fusion Demonstrator).
Author
Data Conversion Routines; Data Integration; Data Systems

19980210676 Liege Univ., Lab. SURFACES, Belgium
ADAPTIVE INTENSITY MATCHING FILTERS: A NEW TOOL FOR MULTI-RESOLUTION DATA FUSION
deBethune, S., Liege Univ., Belgium; Muller, F., Liege Univ., Belgium; Binard, M., Liege Univ., Belgium; Multi-Sensor Systems and Data Fusion for Telecommunications, Remote Sensing and Radar; Apr. 1998; 15p; In English; See also 19980210650
Contract(s)/Grant(s): OSTC-T3/12/47; OSTC-IN-CH-005; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Many different multiresolution fusion methods have been proposed in the literature. An important actual aim in this field of research is to produce colour composites of multiresolution data preserving both the essential spatial information of the high resolution image and the spectral information content of the low resolution channels, so as to produce pseudo high resolution spectral channels which can be further processed for improved classification or other information extraction purposes. The best integration results in this regard have been obtained by the HPF algorithm and by a new fusion method based on multiresolution analysis of the images using the wavelet transform. A new methodology based on adaptive intensity matching filters using local image statistics to spectrally adjust high resolution images to the radiometry of low resolution channels is described in this paper. The algorithm tends to equalize the mean (LMM algorithm) or the mean and the variance (LMVM algorithm) of the high resolution image with those of the low resolution channels, on a pixel by pixel basis, from the values measured within a local window around each pixel position. The INR (Intensity Normalised Ratio) transform, as defined in this paper, is a fast alternative to the RGB-IHS-RGB transform, and allows an efficient implementation of the intensity matching fusion method, generalised to images with more than three channels. These algorithms are applied to a 1024 x 1024 window extract of a high resolution (5m) KOSMOS KVR 1000 panchromatic image to be fused with a registered low resolution (20 m) SPOT XS image, obtained over

the city of Liege (Belgium). The results obtained for varying filtering window sizes are compared with the HPF filter and the wavelet transform applied to the same set of images.
Author
Adaptive Filters; Multisensor Fusion; Image Resolution; High Resolution

19980210677 Defence Research Establishment Valcartier, Decision Support Technology Section, Val Belair, Quebec Canada
THE FUSION OF ORGANIC AND NON-ORGANIC IDENTITY INFORMATION SOURCES USING EVIDENTIAL REASONING
Bosse, Eloi, Defence Research Establishment Valcartier, Canada; Roy, Jean, Defence Research Establishment Valcartier, Canada; Paradis, Stephane, Defence Research Establishment Valcartier, Canada; Apr. 1998; 12p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

The aim of this paper is to explore the problem of identity data fusion in the context of naval warfare where commanders and their staff require access to a wide range of information to carry out their duties. With the increasing use of the remote sources and the increasing use of information that has already been fused, there is a requirement to define an identity data fusion function that can handle organic and non-organic, local and remote types of information characterized by different accuracy and timeliness. This paper is a step towards the definition of an architecture that can perform the fusion of organic and non-organic identity data through the use of statistical analysis rooted in the Dempster-Shafer theory of evidence. The goal is to offer the decision maker a quantitative analysis based on statistical methodology that can enhance his/her decision making process regarding the identity of detected objects.
Author
Organic Materials; Quantitative Analysis; Multisensor Fusion

19980210678 Office National d'Etudes et de Recherches Aerospatiales, Complexe Scientifique de Rangueil, Toulouse, France
PIXEL FUSION FOR ROADS DETECTION AND CLASSIFICATION
Fabre, S., Office National d'Etudes et de Recherches Aerospatiales, France; Briottet, X., Office National d'Etudes et de Recherches Aerospatiales, France; Marthon, P., Ecole Nationale Superieure d'Electronique d'Informatique et d'Hydraulique, France; Appriou, A., Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1998; 9p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The opportunity to process several images being acquired simultaneously over the same landscape in different spectral hands provides a better perception of the scene using data fusion methods. This new method classifying the image in two types (target and background) using the radiometric properties of the surface, is particularly powerful for the detection of non resolved objects. The fusion method is defined by using the normal probability density hypothesis to estimate the of each initial image The classification is done hy using a threshold where analytic expression depends on the type of the a priori knowledge. The method is then applied on an image acquired with the hyperspectral scanner sensor: AVIRIS. The chosen target is a non resolved road in one dimension. Different criteria are used to evaluate the performance of the method: statistical properties, good classification percentage, false alarm and non detection errors. We analyze the a priori probability uncertainty on the image obtained after fusion.
Author
Pixels; Multisensor Fusion; Airborne Equipment; Image Classification

19980210679 Physics and Electronics Lab. TNO, The Hague, Netherlands
SENSOR SYNERGETICS: THE DESIGN PHILOSOPHY OF THE SENSOR FUSION DEMONSTRATOR AND TESTBED (SFD) AT TNO-FEL
vanderWal, A. J., Physics and Electronics Lab. TNO, Netherlands; Apr. 1998; 26p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Although the potential of sensor and data fusion as a way to improve situation awareness nowadays is widely regarded as a valuable tool by the military R&D community, there is still little quantitative evidence available that supports the acclaimed benefits of generic fusion methodologies and thus justifies their application. It is therefore legitimate to ask how much value sensor fusion adds to the observation process. In case studies this question is seldom addressed and it is therefore tempting to ask, whether the acclaimed advantages of sensor fusion are 'hype' or real. In this paper we will try to identify in what situation the application of sensor fusion techniques may be beneficial and which sensor fusion techniques seem to be among the most promising. The starting point of our discussion is the observation that the added value of fusion of similar sensors must originate from a nonlinear combination of sensor data streams. This observation naturally gives rise to the application of novel nonlinear models, e.g. from the area of softcomputing, viz. fuzzy logic, neural networks and evolutionary programming. In addition a trend in research can be observed to apply fusion techniques almost exclusively to 'high-level' fusion (i.e. levels 2 and 3 of the JDL data fusion process model), implicitly considering fusion on the sensor level to be much less of a challenge. Motivated by the fact that high quality primary data are of paramount importance to the success of all subsequent signal processing stages, we argue against this view in this paper. In contrast to the classical data fusion approach, at TNO-FEL it was decided to start up a sensor fusion approach, in which an integrated approach towards sensor optimization, sensor management, and early fusion is pursued. Only in this way one may hope to attain the goal of sensor fusion, viz. an improved situation assessment. Concentrating on the primary information sources, i.e. the sensors, and using their synergy at the earliest stages of signal processing, inevitably forces one to invest in state-of-the art data-acquisition and real-time (pre)processing facilities. This will be illustrated by discussing some of the design issues of the FEL sensor fusion demonstrator (SFD) testbed. The SFD project has been started up by the end of 1996 and initial concepts have meanwhile been defined. The hardware and software concepts of this testbed will be described as well as the functionality that we hope to implement.
Author
Multisensor Fusion; Imaging Techniques; Signal Processing; Terrain Analysis; Information Systems; Data Acquisition

19980210680 Defence Evaluation Research Agency, Malvern, United Kingdom
THE NEMESIS IDENTIFICATION DATA FUSION DEMONSTRATOR
Griffith, P. N., Defence Evaluation Research Agency, UK; Hooper, L. A., Defence Evaluation Research Agency, UK; Everitt, W. M., Defence Evaluation Research Agency, UK; Apr. 1998; 7p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The NEMESIS programme at DERA Malvern was instituted to investigate aspects of multi-sensor, single node data fusion applied to the task of air target identification (ID) in the military environment. In recent years, a reduction of force numbers combined with the introduction of more capable weapon systems, such as precision guided weapons and beyond visual range missiles has made the requirement for accurate, timely, reliable and robust target identification a high priority for air defence forces. After much research during the last 25 years into ID technologies and techniques, it is generally conceded that no single identification technology or system can now nor will, in the foreseeable future, satisfy all the operational capabilities and performance requirements needed from air target identification systems. The enforced use of several identification sensors and sources implies the need for the fusion of the ID data derived from these different sensors and sources. Studies have indicated that automated ID fusion is likely to provide accuracy, consistency, timeliness and manpower benefits. The NEMESIS programme, sponsored by the UK MoD, has investigated the application of a dedicated NATO air target ID data fusion algorithm, NATO STANAG 4162, to a multisensor, single node SHOrt Range Air Defence (SHORAD) demonstrator system. This paper describes the demonstrator package, the sensors, the fusion process and the results.
Author
Multisensor Applications; Multisensor Fusion; Weapon Systems; Missiles

19980210683 Environmental Research Inst. of Michigan, Ann Arbor, MI United States
IMAGERY AND SIGNALS INTELLIGENCE DATA FUSION: ISSUES AND METHODS
Waltz, Edward L., Environmental Research Inst. of Michigan, USA; Hart, Jerry, BTG, Inc., USA; Apr. 1998; 11p; In English; See also

19980210650; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

Imagery and Signals Intelligence (IMINT and SIGINT) data sources and processing have traditionally followed independent channels, with cross use of the information being achieved only by manual human interaction between users at the end of their respective channels. The characteristics of each of these sources are quite different, making automatic correlation of the data a challenging task, but the rewards of correlated data hold the promise for more accurate and robust surveillance than now available from either independent source. IMINT, for example, is characterized by a low revisit rate, high spatial fidelity and broad spatial context, while SIGINT provides a high revisit rate, low spatial fidelity and a broad temporal context. This paper describes the specific issues that face designers who seek to automatically fuse imagery and signal data - and the methods used to overcome the obstacles posed by the fundamental differences in the data types. Four areas of IMINT-SIGINT fusion are addressed: 1) fusion for cross-cueing and sensor management, 2) fusion for improved target geolocation, 3) fusion for increased target detection and identification confidence, and, 4) fusion for improved visualization of the battlefield. The paper provides examples illustrating future solutions using terrain data, UAV imaging sensors, and real-time-in-cockpit (RTIC) techniques illustrated by ERIM-developed technologies. The integration of these capabilities into joint intelligence systems is illustrated by BTG-developed technologies. The paper addresses two of the specific topics listed in the AGARD call for papers: 1) Applications of multiple sensors and data fusion in - target recognition and surveillance, 2) Sensor data networks across imaging and non-imaging sensors.
Author
Imaging Techniques; Data Processing; Imagery; Multisensor Fusion; Surveillance; Target Acquisition; Target Recognition

19980210685 Defence Evaluation Research Agency, Command Systems Dept., Malvern, United Kingdom
THE NATO DATA FUSION DEMONSTRATOR PROJECT
Skinner, J. M., Defence Evaluation Research Agency, UK; Apr. 1998; 8p; In English; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper defines data fusion in the context of the land battle and the military intelligence cycle, it describes the NATO Data Fusion Demonstrator concept and the key aspects of the current design and concludes with a description and evaluation of the results achieved to-date.
Author
Multisensor Fusion; Imaging Techniques; Remote Sensing; Signal Processing

19980210688 Office National d'Etudes et de Recherches Aerospatiales, Ingenieur de Recherche, Paris, France
COMBINING OF INFORMATION AND PHYSICAL NETWORK FOR THE SOL-AIR MULTI-SENSOR SYSTEM *FUSION D'INFORMATIONS ET RESEAUX PHYSIQUES POUR LES SYSTEMES MULTI-SENSEURS SOL-AIR*
Nahum, C., Office National d'Etudes et de Recherches Aerospatiales, France; Apr. 1998; 8p; In French; See also 19980210650; Copyright Waived; Avail: CASI; A02, Hardcopy; A04, Microfiche

The work conducted for the Computation of the Arienne Group of Defense Coordination of DRET (Defense Research and Technology) presents a methodology for the configuration, evaluation and improvement of the sol-air multi-sensor systems of the SACP type. They are being solidified by the Development of ROSACE (Research for the Optimization of Systems, Anti-aeriens Evaluation Concept) are described. The first part of the document presents the ROSACE logic. The second part is dedicated to the problem of achieving basic information of the multi-sensor system. In particular, the conditions of compatibility between the algorithmic logic and the physical communication system are studied.
Author
Information Systems; Multisensor Applications; Networks

19980210690 Institute for Human Factors TNO, Soesterberg, Netherlands
FUSION OF VISIBLE AND THERMAL IMAGERY IMPROVES SITUATIONAL AWARENESS
Toet, A., Institute for Human Factors TNO, Netherlands; IJspeert, J. K., Institute for Human Factors TNO, Netherlands; Waxman, A. M., Massachusetts Inst. of Tech., USA; Aguilar, M., Massachusetts Inst. of Tech., USA; Apr. 1998; 12p; In English; See also 19980210650; Original contains color illustrations
Contract(s)/Grant(s): F19628-95-C-0002; Copyright Waived; Avail: CASI; A03, Hardcopy; A04, Microfiche

A new colour image fusion scheme is applied to visible and thermal images of military relevant scenarios. An observer experiment is performed to test if the increased amount of detail in the fused images can improve the accuracy of observers performing a detection and localisation task. The results show that observers can localise a target in a scene (1) with a significantly higher accuracy, and (2) with a greater amount of confidence when they perform with fused images (either gray or colour fused), compared to the individual image modalities (visible and thermal).
Author
Thermal Mapping; Image Converters; Image Resolution; Imagery

19990007861 MacDonald, Dettwiler and Associates Ltd., Richmond, British Columbia Canada
IMAGE DATA MANAGEMENT FOR TACTICAL UNMANNED AIRBORNE SURVEILLANCE
Davenport, Michael R., MacDonald, Dettwiler and Associates Ltd., Canada; Wehn, Hans, MacDonald, Dettwiler and Associates Ltd., Canada; Burke, Ian, MacDonald, Dettwiler and Associates Ltd., Canada; Jul. 1998; 12p; In English; See also 19990007836; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper examines how more information and better information can be extracted from UAV data streams, and how that information can be presented to operators in the most effective manner possible. It examines the role of data management in all three phases of tactical reconnaissance: mission planning, mission execution, and post-mission analysis. It then describes some newly-developed tools for precisely positioning each pixel, fusing multiple images, extracting new information, and providing an accessible archive of that information. When implemented successfully, such a data management system can substantially increase the operational value of existing UAVs.
Author
Data Flow Analysis; Data Management; Management Systems; Image Processing; Data Simulation; Data Integration; Display Devices; Optical Data Processing

19990014362 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
INFORMATION CORRELATION/FUSION
Onken, R., Advisory Group for Aerospace Research and Development, France; Dewey, D., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 55-58; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

A definition of Information Correlation/Fusion (IC/F), reasons for using IC/F, application of IC/F to Unmanned Tactical Aircraft (UTA), application of IC/F to mission management, improvements needed by 2020 in IC/F for UTA's, improvements needed by 2020 in IC/F for mission management and other supporting technologies needed by 2020 are presented.
CASI
Multisensor Fusion; Pilotless Aircraft; Data Management

19990014368 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
MILITARY INFORMATION HIGHWAY
Cymbalista, J., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, 69-72; In English; See also 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

"Information is power" goes the well-known saying, and the military establishment is adamant that the better informed they are, the greater their readiness to overcome foes. This, true though it be, is not enough. The example of the two chessplayers - both having thorough, perfect knowledge of the situation - shows that what gives a significant advantage is not only situational knowledge (assuming the same, high degree of access to information for both players) but also the use that is made of it, i.e. primarily how this variegated mix of data is to be

processed and what strategy can be derived therefrom. Only the transmission of information, from the time it is collected up until when it is dispatched to the user, is addressed in this paper.
Author
Military Technology; Information Flow; Information Transfer

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LAW, POLITICAL SCIENCE AND SPACE POLICY

19960003883 Alenia Spazio S.p.A., Turin, Italy
TAILORING TEST REQUIREMENTS FOR APPLICATION IN MULTINATIONAL PROGRAMMES
Messidoro, Piero, Alenia Spazio S.p.A., Italy; Ballesio, Marino, Alenia Spazio S.p.A., Italy; Comandatore, Emanuele, Alenia Spazio S.p.A., Italy; AGARD, Space Systems Design and Development Testing; Mar 1, 1995, 6 p; In English; See also 19960003881; Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Participation in international cooperative programs is giving rise to an interesting experience of test requirement tailoring to define mutually agreed specifications. Significant differences, in particular between the European and U.S. approach, have been pointed out in areas like: qualification/acceptance test philosophies, equipment and system thermal cycling, vibro-acoustic excitation and qualification test article quality standard. The paper focuses on the experience gained in discussing the above points and suggests possible improvements towards an international standard for space testing.
Derived from text
International Cooperation; Procedures; Quality Control; Space Programs; Specifications; Test Stands

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URBAN TECHNOLOGY AND TRANSPORTATION

19950026706 Honeywell Technology Center, Minneapolis, MN, United States
DUAL USE: OPPORTUNITIES, PAYOFFS, AND CHALLENGES
Cunningham, Thomas, Honeywell Technology Center, USA; AGARD, Dual Usage in Military and Commercial Technology in Guidance and Control; Mar 1, 1995, 7 p; In English; See also 19950026705; Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Significant payoffs can be achieved by increasing the interaction between military and commercial business and technology communities. This paper describes a few of the opportunities available to practitioners of guidance, navigation and control technologies to work in this dual use world. Examined from the point of view of an engineer who has been solving primarily military problems, it is hoped that the NATO AGARD reader as well as our new friends from the Cooperating Countries will benefit. The paper emphasizes three major themes: (1) Guidance, Navigation, and Control (G, N, and C) technologies and engineers are highly qualified to solve important nonmilitary problems; (2) The use of common solutions to commercial and military problems, from components to systems, has significant cost payoffs to future affordable military systems; and (3) Commercial systems, particularly aviation, offer technology advantages which should be exploited for affordable non-recurring developments and reduced cycle times in future military systems.
Derived from text
Guidance (Motion); Guidance Sensors; Multisensor Applications; Navigation; Technology Assessment; Technology Utilization

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LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see 18 Spacecraft Design, Testing and Performance.

19970026367 Fluid Gravity Engineering Ltd., Liphook, United Kingdom
PLANETARY ATMOSPHERES, BASIC THERMODYNAMICS AND REGIMES
Smith, Arthur, Fluid Gravity Engineering Ltd., UK; May 1995; 22p; In English; See also 19970026365; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In Sessions 2 to 4 we shall revue some of the basic phenomena relevant to capsule aerothermodynamics prior to the more detailed Sessions later in the course. Much of the material in these first Sessions is undergraduate material and refers to simple methods in order to introduce the student to the subject with the emphasis on understanding the phenomena rather than a briefing on state of the art techniques. However understanding aerothermodynamics requires understanding of basic mathematics, physics and chemistry which is assumed for this course. A short list of references is given to each section which has deliberately been kept small such that the student should aim to read all of these in detail. Some of the classic works have been included which although early give good detailed explanations of the subject phenomena. Session 2 Begins with the atmosphere structure followed by some basic thermodynamics used in aerothermodynamics, and ends with a revue of the classical aerodynamic and aerothermal regimes encountered by a capsule during entry.
Author
Aerothermodynamics; Planetary Atmospheres; Aerodynamic Heating; Hypersonic Reentry; Spacecraft Reentry; Hypersonic Flow; Rarefied Gas Dynamics

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GENERAL

19980210650 Advisory Group for Aerospace Research and Development, Sensor and Propagation Panel, Neuilly-Sur-Seine, France
MULTI-SENSOR SYSTEMS AND DATA FUSION FOR TELECOMMUNICATIONS, REMOTE SENSING AND RADAR *LES SYSTEMES MULTI-SENSEURS ET LE FUSIONNEMENT DES DONNEES POUR LES TELECOMMUNICATIONS, LA TELEDETECTION ET LES RADARS*
Apr. 1998; 416p; In English; In French, 29 Sep. - 2 Oct. 1997, Lisbon, Portugal; See also 19980210651 through 19980210690; Original contains color illustrations
Report No.(s): AGARD-CP-595; ISBN 92-836-0051-7; Copyright Waived; Avail: CASI; A18, Hardcopy; A04, Microfiche

This publication reports the unclassified papers presented at a specialists' meeting held by the Sensor and Propagation Panel at its Fall 1997 meeting. The topics covered included: - Applications of multiple sensors and data fusion - Data fusion techniques and methods - Sensor data networks and management techniques - Validation studies, experiments, technologies.
Author
Telecommunication; Remote Sensing; Communication Networks; Data Transmission; Management Methods; Multisensor Fusion

Subject Term Index

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