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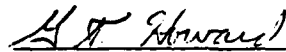
RADM R.H. SHUMAKER
Superintendent

DEAN D.A. SCHRADY
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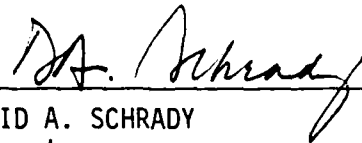
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This report was prepared by:



G.T. HOWARD
Director
Research Administration

Released by:



DAVID A. SCHRADY
Provost

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Twenty-seven projects of Independent Research/Independent Exploratory Development were funded by the NPS Foundation Research Program. This research was in the areas of Computer Science, Mathematics, Administrative Sciences, Physics, Electrical and Computer Engineering, Meteorology, Aeronautics, and Mechanical Engineering. A tabulation in the Appendix identifies the area of research and the investigator(s). The category of independent research or independent exploratory development is also identified for each research task.			
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OVERVIEW OF THE NPS FOUNDATION RESEARCH PROGRAM FY 1984

The principal thrust of the research and exploratory development program at the Naval Postgraduate School (NPS) stems from its mission:

To conduct and direct advanced education of commissioned officers, and to provide such other technical and professional instruction as may be prescribed to meet the needs of the Naval Service; and in support of the foregoing to foster and encourage a program of research in order to sustain academic excellence.

A portion of the research performed at NPS is conducted through grants from the Chief of Naval Research. These funds provide the basis for the NPS Foundation Research Program reported here. Additional research sponsored by other sources as well is reported annually in A Summary of the Naval Postgraduate School Research Program.

A major goal of the Foundation Research Program is to strengthen the base of technology at NPS and to conduct research in areas of science and technology of interest to the Navy. Specific objectives include:

- * sponsoring research efforts of junior faculty enabling them to establish a strong research program in their chosen field.
- * allowing experienced faculty to change the course of their research programs.
- * providing the opportunity for the accomplishment of meritorious research projects that have no sponsor, and
- * increasing the general research capability of the Naval Postgraduate School through capital equipment procurement.

These objectives are pursued with the ultimate goal of stimulating the highest quality research program at NPS in support of the educational program received by students.

The Foundation Research Program is administered internally by a Research Council comprised of selected faculty members. The function of the Research Council is to properly implement the goals and objectives of the program with a view toward approving meritorious proposals submitted by the NPS faculty.

This report describes the accomplishments of the Foundation Research Program for FY 1984. The summaries of the research efforts are organized by academic departments. Some projects are oriented toward initiating and conducting scientific and applied research of a long-range nature in areas of special interest to the Navy. Other efforts are for conducting exploratory development deriving from scientific program areas of current Navy interest.

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**DEPARTMENT
OF
COMPUTER SCIENCE**

Title: Methodology for the Formal Specification of Portable Software Interfaces

Investigator: Daniel L. Davis, Associate Professor of Computer Science

Sponsor: NPS Foundation Research Program

Objective: To develop a methodology for the abstract specification of computer system resources to facilitate the development of portable resource interfaces.

Summary: A major factor in the high cost of software is the lack of reusability and portability. In this research the methodology called "algebraic specification" has been adapted to the specification of physical resource abstractions in order to describe portable, implementation independent software interfaces. Such interfaces have been implemented before using ad hoc methods. The purpose of this work has been to work out a theoretical basis for such efforts.

A general methodology has been worked out using algebraic semantics. This methodology provides a formal theory of specification equivalence, adequacy, and computability. Also, it establishes a precise theory of implementation and formal correctness.

Complete specifications for an abstract, portable processor have been designed. A formal grammar for a specification language has been developed and an implementation of the abstract processor has been designed.

Title: Top-Down Reasoning About Statistics on Databases

Investigator: N. C. Rowe, Associate Professor of Computer Science

Sponsor: NPS Foundation Research Program

Objective: To develop a comprehensive alternative to sampling for estimating values of statistics on a database, using expert systems methodology from artificial intelligence.

Summary: After preliminary study, research was focussed on two areas of highest potential payoff in statistical estimation, estimation of sizes of set intersections and unions (because of its application to computer performance enhancement), and estimation of statistics on transformed variables from statistics on the original variables (because of the strong preliminary results obtained). Detailed theoretical investigation was done on both topics, and a number of new results were obtained. Computer experiments were then done to validate the formulae found, and did confirm them. The set intersection study was done in the computer language Prolog, and the variable transformation study was done in the language Interlisp, and this also provided an opportunity to evaluate the relative merits of two rather different languages for this type of research.

Publications:

N. C. Rowe, "Absolute Bounds on the Mean and Standard Deviation of Transformed Data for Constant-Derivative Transformations", Technical Report NPS52-84-006, Naval Postgraduate School, July 1984. Submitted to a journal.

N. C. Rowe, "Diophantine Inferences from Statistical Aggregates on Few-Valued Attributes", Proceedings of the International Conference on Data Engineering, Los Angeles, CA, April 1984, 107-110.

N. C. Rowe, "Antisampling for Estimation: An Overview". Submitted to a journal.

N. C. Rowe, "Absolute Bounds on Set Intersection and Union Sizes Using Precomputed Information", in progress.

**Conference
Presentations:**

N. C. Rowe, "Antisampling for Estimation",
Computer Science and Statistics: 16th Symposium
on the Interface, Atlanta, GA, March 1984.

N. C. Rowe, "Inferences About Numbers",
Artificial Intelligence/Robotics Technology
Review, Naval Postgraduate School, Monterey, CA,
September 1984.

Title: The Effects of Real-Time Display Generation on the Architecture of Graphics Display Systems

Investigator: Michael J. Zyda, Assistant Professor of Computer Science

Sponsor: NPS Foundation Research Program

Objective: The effects of special purpose VLSI architectures on the design of the graphics display system will be evaluated, with special attention to data input/output rates, human interaction, and currently available graphics display system functionality. Several graphics algorithms that have the potential for VLSI implementation will be identified and studied, with the goal being a characterization of the changes necessary in the architecture of the graphics display system required by VLSI based, real-time display generators.

Summary: From the 1st of July 1984 (the start of the research quarter for this proposal) until the 30th of September 1984, the following work has been carried out: The first objective of the study was to examine the proposed architecture of one real-time display generator, the contour surface display generator of [Zyda,1984a]. Part of this objective has been carried out in the form of three technical memoranda [Zyda,1984b], [Zyda,1984c], and [Zyda,1984d]. Part of these studies was the development of a modeling methodology for evaluating the physical parameters inherent to both the application, and the architecture.

The second objective of the study was to examine the input and output parameters obtained from the system model in order to determine exactly how that display generator can be interfaced to a graphics display system. This study was held up due to the prolonged procurement process for the necessary equipment, a Silicon Graphics, Inc. IRIS-1400 Graphics Workstation. After having been ordered in late March 1984, the Graphics Workstation arrived finally on the 5th of October 1984.

The third objective of the study was the identification of other graphics algorithms with the potential for implementation in VLSI. This work has begun through the efforts of two current thesis students. The studies being carried out are cursory examinations of these algorithms for their distributability among multiple processors. Part of these studies will be an attempt to determine if the changes proposed for the graphics system for the contour surface display generator are applicable to other real-time display generators.

Publications:

Zyda, Michael J., "The Feasibility of a Multi-processor for Real-Time Contour Surface Display Generation," Technical Report NPS52-84-xxx, Monterey, California: Department of Computer Science, Naval Postgraduate School, September 1984d (in preparation).

Zyda, Michael J., "Real Time Contour Surface Display Generation," Technical Report NPS52-84-013, Monterey, California: Department of Computer Science, Naval Postgraduate School, September 1984c.

Zyda, Michael J., "A Decomposable Algorithm for Contour Surface Display Generation," Technical Report NPS52-84-011, Monterey, California: Department of Computer Science, Naval Postgraduate School, August 1984b.

Zyda, Michael J., Algorithm Directed Architectures for Real-Time Surface Display Generation, D.S.c. Dissertation, Dept. of Computer Science, Washington Univ., St. Louis, Missouri, 1984a.

Theses Directed:

Gaddis, Michael E., "The Fractal Geometry of Nature: Its Mathematical Basis and Application to Computer Graphics", (forthcoming.)

Walker, Robert A., "A Methodology for Evaluating the Implementation of Multiprocessor Architectures for Real-Time Weapons Control Systems", (forthcoming.)

Sahintepe, Mustafa, "A Graph Theoretic Algorithm for Contour Display Generation", (forthcoming.)

Coomes, Ken, "The Use of VLSI for Real-Time Display Generation", (forthcoming.)

DEPARTMENT.
OF
MATHEMATICS

Title: Research into Problems of Group Decision Theory and Information Pooling

Investigator: G. Owen, Professor of Mathematics

Sponsor: NPS Foundation Research Program

Objective: This was the beginning of a long-term research project designed to study several mechanisms used for the pooling of information and for making decisions in groups. The general objective is to give optimal (or at least good) methods of aggregation (in the sense of maximizing the probability of a correct decision).

Summary: Research in this phase of the project focused on (a) voting in deliberative bodies and (b) pari-mutuel betting systems. For (a), it was shown that, under certain circumstances, i.e. when certain members of the group tend to vote together, an indirect majority rule might well give better results than direct majority rule voting, and certain mixed (semi-proportional) systems might be better than either direct or indirect majority. For (b), it was shown that, at a race track, an equilibrium set of pari-mutuel odds will (under very broad conditions) exist, which in effect serves as a method of aggregating the individual bettors' probability estimates on the outcome of the race.

Publications: G. Owen, "Fair Indirect Majority Rules," in Aggregation of Opinions and Group Decisions, ed. G. Owen and B. Grofman, Reidel, forthcoming (late 1984).

G. Owen, "Pari-Mutuel as a System of Information Aggregation," Technical Report NPS 53-85-0001, Department of Mathematics, Naval Postgraduate School, October 1984.

Conference Presentations: The report "Fair Indirect Majority Rules" was presented at the annual meeting of the Public Choice Society, Phoenix, AZ, 28 March 1984, and at the Fifth Latin American Meeting of the Econometric Society, Bogota, Colombia, 24 July 1984.

**DEPARTMENT
OF
ADMINISTRATIVE SCIENCES**

Title: An Empirical Investigation of the Behavior of Reactive Control Systems

Investigator: S. L. Ansari, Adjunct Professor, Department of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To empirically test and model the behavior probability distribution) of free flowing speeds on U. S. highways in response to the imposition of the 55 mph speed limit in 1974. Traffic speeds were used as prototypes for so-called reactive control systems in which the control policy itself (as opposed to negative feedback) causes behavioral changes in the system.

Summary: The project was funded in January 1984. Since then 80% of the work has been completed. This includes an extensive amount of data collection from the states of New York, Nevada, California and Texas. Preliminary analysis of this data is also complete and some results are currently available. A final model is presently being refined and tested to complete the project.

Conference Presentation: S. L. Ansari, "Modeling Human Behavior in Reactive Control Situations," TIMS Annual Meeting, Copenhagen, Denmark, June 1984.

Title: Alternative Models of Corporate Capital Investment and Their Implications for DoD Procurement

Investigators: P. Bromiley, Assistant Professor
D. C. Boger, Assistant Professor
Department of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To compare six alternative models of corporate capital investment based on their predictive capabilities.

Summary: In response to concerns with the productivity and surge capacity of the defense industrial base, the Department of Defense has implemented a number of programs to improve the production facilities and profitability of defense contractors. Unfortunately, these programs have been undertaken without a thorough knowledge of the capital investment behavior of defense contractors. However, this is not surprising since several alternative models of investment behavior exist, and the models have not been well compared empirically. This research compared alternative models of investment based on how well they predict. The sample of firms included both defense-oriented and non-defense-oriented firms. It was shown that simpler models were able to predict at least as well as more complex models.

Publications: A technical report is in preparation, and a paper is being submitted to the open literature.

Title: Model Patternmatching in Model Management Systems

Investigator: D. R. Dolk, Assistant Professor of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: Study the structural characteristics of classes of models with regard to how they may be matched to potential solution algorithms. Determine a methodology for this and develop algorithms which implement this methodology.

Summary: This project is a continuation of research funded by the Foundation in the previous fiscal year.

Title: An Evaluation of Leasing as a Financing Strategy Within the Navy

Investigator: J. G. San Miguel, Professor of Accounting, Department of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: The aim of this proposed research was to evaluate the cost effectiveness of leasing as an alternative financing strategy for the Department of the Navy specifically and the Department of Defense generally. This evaluation of the efficacy of leasing must be twofold: first, from the point of view of DoN in achieving its overall objectives for the program for which the equipment is leased, and second, from the view of the overall operation of the U. S. government.

Summary: Recently both the Department of the Navy and the Department of Defense have initiated plans to lease capital equipment as opposed to the use of appropriated funds to purchase capital equipment. Congress, the General Accounting Office, and the public have expressed concern on this initiative. Although usually far more complex, most leasing arrangements between an owner of capital equipment and someone who wishes to use the capital equipment are viewed as a "rental" arrangement. The DoN's lease arrangements for thirteen ships for its Military Sealift Command are long-term contracts for "transportation services". The length of lease and renewable options, tax benefits, cancellation provisions (DoN guarantees for legal fees and lost interest) involved in the agreements are extremely more complex. An exhaustive study of the extant literature was completed and numerous personal interviews have been conducted with individuals within DoN and others knowledgeable in leasing and the shipbuilding industry. The research is still in progress and should be completed by March 1985.

Thesis Directed: R. E. Ratcliff, "A Framework for the Procurement of Assets Through Leasing Arrangements," Master's Thesis, December 1984.

DEPARTMENT
OF
PHYSICS

Title: Radiation Effects on Infrared Detector Materials

Investigators: K. C. Dimiduk, Adjunct Professor of Physics, and F. R. Buskirk, Professor of Physics

Sponsor: NPS Foundation Research Program

Objective: To study the effects of radiation on semiconductor materials used for infrared detectors and on infrared semiconductor devices.

Summary: HgCdTe, InGaAsP and InGaAs were determined to be important systems for study. Sources for these materials or devices were located and samples were ordered. Various test systems were constructed so that changes in the samples due to irradiation could be determined. In particular, a Beckman 1A spectrophotometer was modified so that changes in the spectral output of LEDs or spectral response of detectors could be monitored. A mount was made for the LINAC so that the LEDs and detectors could be operated during irradiation. A setup was built to make Hall measurements on infrared detector materials at liquid nitrogen temperatures (low temperatures required by the narrow band gap of these materials). Measurements have been made on each of these systems. A mount to keep HgCdTe samples cold during irradiation is under construction. Several InGaAsP LEDs and InGaAs detectors have already been irradiated.

This is a two year project. The work in FY 84 has been primarily equipment construction and preliminary experiments. The work in FY85 will concentrate on data collection and analysis.

Theses Directed: C. Q. Ness, "Electron Irradiation of Light Emitting Diodes," Master's Thesis, December 1984.

C. P. Bauer, "No Confirmed Title", Master's Thesis, March 1985.

Title: Measurement of Acoustic Ambient Noise in the Cargo Bay of the Space Shuttle During Launch

Investigator: R. Panholtzer, Professor of Electrical Engineering, S. L. Garrett, Assoc. Professor of Physics, O. B. Wilson, Professor of Physics, A. E. Fuhs, Dist. Professor of Aeronautics and Space, E. D. Ewing, Professor of Electrical Engineering, Y. S. Shin, Assoc. Professor of Mechanical Engineering, and M. D. Kelleher, Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program and U.S. Air Force, Space Division

Objective: To measure, record, and interpret the acoustic noise in the Space Shuttle cargo bay during launch using the NASA "Get Away Special" payload program.

Summary: As this is a multidisciplinary effort, the following refers only to work in the acoustics area under Professors Garrett and Wilson which has concentrated on acoustical model analysis of the cargo bay and on instrumentation for the generation and reception of sound. To date we have chosen transducers and amplifiers for this application and created a computerized "shaker table" test facility which can excite these components using a vibration spectrum which closely duplicates the Shuttle's launch environment. Measurements made with the above system indicated that special vibration mounts would have to be constructed to isolate microphones from vibration during lift-off. Those mounts are currently under test. Algorithms for studying cargo bay acoustics resonances using three microphones have been designed, along with a system to excite these resonances remotely prior to launch. These systems will be tested soon.

Theses Directed: C. LD. Sthele, "Microphone Vibration Isolation for Space Shuttle Acoustic Measurements," Master's Thesis, September 1985.

S. E. Palmer, "Automated Cavity Modal
Analysis for Space Shuttle Acoustic
Measurements," Master's Thesis, March
1985.

Title: Parameterization of the Riso Puff Model for Complex Coastal Terrain

Investigators: G. E. Schacher, Professor of Physics and S. Larsen, Adjunct Research Professor

Sponsor: NPS Foundation Research Program

Objective: Develop a complex terrain parameterization for the Riso puff model based on data gathered at Vandenberg AFB.

Summary: Data from Vandenberg AFB includes mean flow and turbulence statistics for 12 locations. The locations include several types of terrain and are spread over a wide enough area to enable flow and turbulence fields to be established. These fields will be used to parameterize a site-specific adaptation of the Riso puff model for the base. Characteristic flow regimes have been established and the turbulence fields are being developed.

Thesis Directed: M. Buell, "Mean Flow and Turbulence in Complex Terrain," Master's Thesis, March 1985.

Title: Atmospheric Optics Instrumentation and Measurements

Investigators: D. L. Walters, Associate Professor of Physics

Sponsor: NPS Foundation Research Program

Objective: To acquire and fabricate the instrumentation needed to perform electro-optical measurements of atmospheric turbulence parameters that degrade laser propagation and initiate field measurements.

Summary: An extensive effort was completed to select the best possible computer system for field data collection and processing, within cost, size, performance, and long term expansion constraints. The Hewlett-Packard series 200 computer was ultimately chosen and acquired over previously used Digital Equipment computers. With this critical decision made, auxiliary components were selected, purchased and acquired. Three designs of an instrument to measure the isoplanatic angle—a critical high energy laser atmospheric parameter—were evaluated and two designs were fabricated. Field measurements began at NPS in August.

Publications: A draft open literature paper "Isoplanatic Angle Measurement", has been written and is waiting for the inclusion of specific experimental measurements that verify the design compromises.

Conference Presentation: D. L. Walters, "Isoplanatic Angle Measurements", Optical Society of America Annual meeting, New Orleans, Oct. 1983.

Thesis Directed: E. Kim, "Noise Characteristics of a Silicon Avalanche Photodiode," Master's Thesis, December 1984.

**DEPARTMENT
OF
ELECTRICAL AND
COMPUTER ENGINEERING**

TITLE: Image Data Compression and Representation by Piece-wise Surfaces Over Irregular Patches

INVESTIGATOR: C-H Lee, Associate Professor of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: This is a study of the surface representation of image data. An image surface can be presented as a collection of irregular patches of parametric spline surfaces. This study is concentrated on maximizing the achievable data compression ratio.

SUMMARY: One of the important issues in processing digital images is related to the total volume of data involved. How to store the images, how to retrieve them, and how to process them in realistic time? Many efforts were spent in investigating clever ways to code the image so that the total data is compressed. For a regular 512 x 512 element picture with 256 levels of gray it is necessary to require a storage capacity of 64 binary megabytes (2^{26}) to accommodate it. For multiple-image processing or change detection in a sequence of time frame images the storage capacity problem becomes serious quickly. The research effort proposed here is aimed at the image data compression problem.

PUBLICATIONS: C-H Lee, "Restoring Spline Interpolation of CT Images," IEEE Transaction on Medical Imaging, Volume MI-2, No. 3, pp. 142-149, September 1983

C-H Lee, "Recursive Region Splitting at Hierarchical Scope Views," submitted to Computer Vision, Graphics and Image Processing, in progress.

THESIS DIRECTED: C. T. DeMiranda, "Image Data Compression Using Uneven Knot Positions," Engineer's Degree Thesis, June 1984

TITLE: Perturbative Model Analysis of the Back-Scattering Characteristics of a Missile over Several Frequency Bands

INVESTIGATOR: H-M Lee, Assistant Professor of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: (1) To develop an analytic theory on the scattering of electromagnetic waves from tubular cylinders of finite length. This will add to the list of only a few finite sized objects of which the vector scattering problems have been analytically solved.

(2) To apply this theory toward the identification and the reduction of the cross sections of targets with increasingly complex shapes.

SUMMARY: A theory of the scattering surface current on a tubular cylinder was developed and is now being compared to experimental results. Based on this theoretical understanding, scattering data from models with small deviations from a tubular cylinder will be interpreted. Phenomenological theories on these perturbed models will be developed.

CONFERENCE PRESENTATIONS: H-M Lee, "Interaction of Modal Currents on a Tubular Cylinder of Finite Length," 1984 URSI & IEEE AP-S International Symposium at Boston.

THESIS DIRECTED: Mario Loric, "Radar Target Identification through Electromagnetic Scattering Studies," Master's Thesis, December 1984.

TITLE: Inherent Tracking Errors of a Monopulse Radar

INVESTIGATOR: H-M Lee, Assistant Professor of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To study the inherent angular tracking errors of monopulse radars and to develop, based on the findings of this study, countermeasures against this type of radar.

SUMMARY: A radar is designed for tracking a point target but is always used for tracking a complex target. This will result in errors in the estimated target location by the radar. This type of error has been discussed over the previous 25 years without its origin being recognized. Related problems have been over-simplified and journal publications have been infested with erroneous claims. This research is intended to point out the inadequacies in previous work and to lay the foundation for future developments in this area.

THESIS DIRECTED: Dae Hyun Park, "Inherent Angular Tracking Error in an Amplitude Comparison Monopulse Radar," Master's Thesis, December 1984.

Sopon Bumroongpol, "Angular Tracking Error in a Phase Comparison Monopulse Tracking Radar: A Critical Review and Extension of the Phase Front Distortion Approach," Master's Thesis, December 1984.

TITLE: Acoustic Tactical Data Link

INVESTIGATOR: P. H. Moose, Associate Professor of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

SUMMARY: Based on the feasibility analysis conducted by LT John Lambert, an ASW student at NPS, we have initiated research activities to develop the various components of a high data rate underwater acoustic communications link. A message generator and encoder has been completed during the summer of 1984. The coherent multi-tonal, phase shift keyed digital transmitter is being designed as a thesis project by an ECE student, LCDR DeFrank. A parametric acoustic projector has been acquired from NUSC/NL. Foundation funds were used to purchase the 1500 volt power supply required to operate this transducer.

Plans for 1985 are:

- 1) To conduct research on the digital sonobouy receiver.
- 2) To test the transmitter with the parametric projector for power output, directionality and signal fidelity. Funding will be sought from external NPS sources.

TITLE: Propagation of Scalar Acoustic Waves

INVESTIGATOR: Daniel Guyomar, National Research Council Associate and John Powers, Professor of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To apply spatial frequency domain techniques to the modeling to the propagation of pulsed and transient scalar waves in lossless and lossy media. The technique would allow the application of computer-efficient FFT algorithms to problems that have previously used more complicated integrals based on geometrical interpretation.

SUMMARY: Techniques have been identified and used in computer simulations that model the propagation in (1) lossless media, (2) media with an absorption coefficient that is liner with frequency, and (3) media with an absorption that is quadratic in frequency. The techniques have been used to model transient propagation from focused transducers and planar sources. Additionally simplifications have been identified that increase the computational efficiency of the technique in calculating the fields from axisymmetric transducers.

PUBLICATIONS:

D. Guyomar and J. Powers, "Diffraction of Pulsed Ultrasonic Waves in Lossless and Absorbing Media," in progress.

D. Guyomar and J. Powers, "Transient Fields Radiated by Curved Surfaces--Application to Focusing," Journal of the Acoustical Society of America. Vol. 75, pp. 1564-1572, 1984.

D. Guyomar and J. Powers, "Boundary Effects on Transient Radiation Fields from Vibrating Surfaces," Journal of the Acoustical Society of America, forthcoming.

D. Guyomar and J. Powers, "Transient Radiation from Axially Symmetric Sources," in progress.

CONFERENCE PRESENTATIONS:

D. Guyomar and J. Powers, "Diffraction of Pulsed Ultrasonic Waves in Lossless and Absorbing Media," 107th Meeting of the Acoustical Society of America, Norfolk, VA, 7-10 May 1984.

TITLE: Underwater Acoustic Propagation and Scattering in a Random Ocean - A Linear Systems Theory Approach

INVESTIGATOR: L. J. Ziomek, Assistant Professor of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To derive transfer functions and coherence functions of the random ocean medium based upon the WKB and parabolic equation approximations. By coupling the transfer functions to various transmit signals and transmit and receive apertures, problems in pulse propagation, underwater acoustic communication, and target detection will be studied via computer simulation of the derived mathematical expressions.

SUMMARY: A time-invariant, space-variant, random transfer function of the ocean volume was derived using the parabolic equation approximation. The ocean volume was characterized by a three-dimensional random index of refraction. The index of refraction was decomposed into a deterministic component and a zero mean random component. In addition, two example calculations were made using the transfer function. The first example involved the derivation of the equations for the random, output electrical signals at each element in a receive planar array of complex weighted point sources in terms of the frequency spectrum of the transmitted electrical signal, the transmit and receive arrays, and the transfer function of the ocean medium. The second example involved the derivation of the coherence function, i.e., the autocorrelation function of the transfer function.

Computer simulation of the equations for the output electrical signals based on the WKB approximation began. A three-dimensional FFT beamformer space-time signal processing algorithm was used to process the computer simulated signals in order to study problems in source localization and underwater acoustic communications.

PUBLICATIONS: L. J. Ziomek, "Linear Time-Variant Space-Variant Filters and the WKB Approximation," Naval Post-graduate School Technical Report, NPS-62-83-058, October 1983.

L. J. Ziomek, "Linear Time-Invariant Space-Variant Filters and the Parabolic Equation Approximation," Signal Processing, in progress.

**DEPARTMENT
OF
METEOROLOGY**

Title: Investigation of the Structure and Evolution of the Coastal ABL using an Acoustic Doppler Sodar System

Investigator: W. J. Shaw, Assistant Professor of Meteorology

Sponsor: NPS Foundation Research Program

Objective: The objective of this effort was to initiate surface-based remote sensing capability for the atmospheric boundary layer which will ultimately yield insight into: the relationship between inversion wind shear and ABL small-scale structure and entrainment energetics; ABL structure resulting from inhomogeneities of the coastal region; and the relationship between the structure of the coastal ABL and larger-scale weather systems. The program is continuing in FY85.

Summary: Software was developed that provides for the transfer of Sodar data from the microprocessor which drives the data acquisition system to the NPS IBM 3033 mainframe. This allows for complete and sophisticated analysis of the data. The Sodar system was deployed at Pt. Pinos, CA--a location which gives exposure both to an essentially undisturbed marine ABL with westerly flow and to a boundary layer influenced by coastal effects when the wind is weak or flow is from other directions. Measurements have been made of the mean wind profiles and small-scale turbulence intensity (C^2_T) throughout the depth of the ABL.

**DEPARTMENT
OF
AERONAUTICS**

Title: The Influence of Spectrum Functions and Filters on the Crossing Frequency of Atmospheric Turbulence

Investigator: J.V. Healey, Associate Professor of Aeronautics

Sponsor: NPS Foundation Research Program

Objective: To investigate the reason for large discrepancies, appearing in various papers and reports in the literature, in the predicted crossing frequency of atmospheric turbulence.

Summary: All structures are more or less elastic and will vibrate when exposed to the fluctuating forces of a turbulent atmosphere. Since all materials have a finite fatigue life, meaning a finite number of oscillations, every oscillation represents a little more damage. The basic crossing theory, that predicts the number of oscillations in a given time, and hence the probable fatigue life of the structure, has been known for about forty years. Various models of the turbulence spectrum and of the filter that measures how the structure responds to the turbulence are currently in use and lead to widely varying predictions of the probable fatigue life of the structure. The current investigation shows that the spectrum functions in use affect life prediction very little, but the form of the filter plays an extremely important role. In particular, band-pass filtering predicts a fatigue life that is very much less than that predicted by other models.

Publication: J.V. Healey, "The Influence of Spectrum Functions and Filters on the Crossing Frequency of Atmospheric turbulence," *Journal of Atmospheric and Oceanic Technology*, December, 1985, pp 590, 597.

Title: Metallized Solid Fuel Ramjet Combustion

Investigators: D. W. Netzer, Professor of Aeronautics and Alon Gany, Visiting Research Contractor

Sponsor: National Research Council/NPS Foundation

Objective: Conduct fundamental, experimental and analytical studies to enhance the understanding of the combustion behavior of ramjets that utilize large mass fractions of metals within the solid fuel.

Summary: Experimental studies have been made using a small two-dimensional combustor to obtain high-speed motion pictures of the metallic combustion process. Particulate surface agglomeration processes and trajectories through the boundary layer have been studied as a function of operating pressure and type of metal in the fuel.

Publications: A. Gany and D. W. Netzer, "Fuel Performance Evaluation for the Solid-Fueled Ramjet," Naval Postgraduate School Technical Report, NPS67-84-012, October 1984.

Title: Wave Rotors and Wave Engines

Investigator: Dr. R. P. Shreeve, Director, Turbopropulsion Laboratory, Department of Aeronautics and Dr. A. Mathur, (Exotech Inc)

Sponsor: NPS Foundation Program and Naval Air Systems Command

Objective: To develop computational techniques to analyze the performance of and flows within wave rotor devices and to show through an experimental program that they work.

Summary: Extensive studies of past and current efforts related to research and development in wave rotor technology have been made to understand key features of the successes (and failures) of the various programs. A one-dimensional Euler code based on the Random Choice Method has been developed and adapted to model unsteady flows with discontinuities, typical of the flows in wave rotor passages. The design of a laboratory scale wave rotor experiment has been completed and the test rig has been assembled. Initial tests have indicated good mechanical integrity of the rig at high speeds (~15000 r.p.m.) and the device has demonstrated consistent self-acceleration at 5000-6000 r.p.m. when run in the 'wave turbine' mode. Further testing will continue after attaching an air dynamometer to absorb the generated shaft power.

Publications: Eidelman, S., Mathur, A., Shreeve, R. P. and Erwin, J., "Application of Riemann Problem Solvers to Wave Machine Design", AIAA Journal, Vol. 22, No. 7, pp. 1010-1012, July 1984.

Mathur, A., Eidelman, S. and Shreeve, R. P., "Numerical Techniques for Wave Rotor Cycle Analysis", ASME Winter Annual Meeting Forum on Unsteady Flow, ASME Publication FED-VOL 15, December 1984.

**DEPARTMENT
OF
MECHANICAL ENGINEERING**

Title: C.A.E. (Computer Aided Engineering) with an APOLLO computer

Investigator: Giles Cantin, Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program

Objective: The APOLLO computer is a new breed of work station especially well adapted for C.A.E. applications. The GRAPHICS capabilities and computing power make it easy to use with many existing systems.

Summary: A graphics package was obtained from the DANFORD Corporation and installed in the machine. Then the GIFTS system was modified and is now running. Modifications were required in some 75 subroutines.

Title: Thermal Mapping of Turbulent Buoyant Jets Using a Microthermocouple Probe

Investigator: William G. Culbreth, Assistant Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program

Objective: This is part of an ongoing research project involving a fundamental study of the properties of buoyant jets in a crossflowing fluid. An experimental facility has been developed that uses a Laser Doppler Velocimeter and a microthermocouple probe to measure temperature and velocity distributions in jets in a non-intrusive manner. Data that has been acquired includes the length of the zone of flow establishment based on turbulence and velocity data, and contour plots of velocity and temperature in heated jets.

Publication: W. G. Culbreth and J. P. Legoff, "Determination of the Length of the Zone of Flow Establishment in a Submerged, Axisymmetric Jet," in progress.

Theses Directed: M. D. Wessman, "Measurement of Velocity Distributions in Turbulent Jets Using a Laser Doppler Velocimeter," Master's Thesis, June, 1983.

P. W. Nickodem, "Measurement of Velocity Distributions in Turbulent Jets in a Cross Flowing Ambient Fluid Using a Laser Doppler Velocimeter," Master's Thesis, June, 1984.

R. J. Matoushek, "Design and Construction of a Computer Controlled Microthermocouple Probe for the Study of Buoyant Jets," Master's Thesis, September, 1984.

Title: Natural Convection in a Liquid Filled Enclosure
With a Heated Protrusion

Investigator: M. D. Kelleher, Professor of Mechanical
Engineering

Sponsor: NPS Foundation Research Program

Objective: To determine the flow patterns, temperature
distributions and heat transfer rates in the
natural convection process from a heated
protrusion in a liquid filled enclosure.

Summary: A flow visualization study of natural convection
in a liquid filled rectangular enclosure with a
small heater protruding into it from one vertical
wall has been conducted. The top and bottom
horizontal surfaces of the enclosure were heat
exchangers whose temperature could be varied
independently. The fluid in the enclosure was
water. The Baker electrochemical technique,
which utilizes a pH indicator, was used for flow
visualization. Photographs have been taken of
the flow patterns for several different locations
of the heater on the vertical wall. Nusselt
numbers for each heater location and for a range
of Rayleigh numbers have also been determined.
The data suggests a trend that, as the heater is
raised within the enclosure, the Nusselt number
decreases.

Theses Directed: Rick H. Knock, "Flow Visualization Study of
Natural Convection From a Heated Protrusion in a
Liquid Filled Enclosure," Master's Thesis,
December, 1983.

Mason C. Reddix, "Flow Visualization of Natural
Convection in a Narrow Rectangular Enclosure
with a Heated Protrusion," Master's Thesis,
September, 1984.

Title: Underwater Shock Response of Submerged Structure

Investigator: Y. S. Shin, Associate Professor of Mechanical Engineering

Sponsors: Defense Nuclear Agency and NPS Foundation Research Program

Objective: (1) To look into the insight of the large deflection elastic-plastic transient response characteristics of submerged structures in the transient acoustic shock loading condition, (2) to perform underwater explosion testing using stiffened plates and to validate the predicted results with that of the experiments, and (3) to evaluate shipboard equipment response to underwater explosion.

Summary: The transient elastic-plastic responses of the submerged stiffened plate to the transverse acoustic loads were predicted using EPSA and USA-STAGS codes. The tripping of stiffener and its effect to the gross shell response are the goal to achieve. The types of the stiffeners include rectangular, T-type and Z-type stiffeners. The underwater explosion testing was performed using the stiffened plate and the test data were correlated with the EPSA and USA-STAGS calculation. The test site is the West Coast Shock Test Facility at Hunter's Point Naval Shipyard located south of San Francisco, CA.

Publications: T. R. Pentz and Y. S. Shin, "On the Field Experiences of INDEX Testing for a Stiffened Flat Plate Model," Shock and Vibration Bulletin, forthcoming.

M. S. Welch and Y. S. Shin, "Numerical Analysis of the Underwater Shock-Induced Responses of Submarine Installed Equipment," Shock and Vibration Bulletin, forthcoming.

Conference
Presentations:

T. R. Rentz and Y. S. Shin, "On the Field Experiences of UNDEX Testing for a Stiffened Flat Plate Model," 55th Shock and Vibration Symposium, Dayton, OH, October, 1984.

M. S. Welch and Y. S. Shin, "Numerical Analysis of the Underwater Shock-Induced Responses of Submarine Installed Equipment," 55th Shock and Vibration Symposium, Dayton, OH, October, 1984.

F. G. Daube and Y. S. Shin, "Postprocessing of UNDEX Responses of Submerged Cylindrical Shell Using PATRAN-G," 2nd PATRAN Users Conference, Newport Beach, CA, May 21-22, 1984.

Theses Directed:

F. G. Daube, "Underwater Shock-Induced Responses of Submerged Cylindrical Structures," Master's Thesis, December, 1983.

M. K. Asada, "An Analytical Evaluation of Spall Suppression of Impulsively Loaded Aluminum Panels Based on a One Dimensional Stress Wave Propagation Model," Master's Thesis, March, 1984.

J. Lee, "Nonlinear Transient Response of Flat Plate to Air Shock Wave," Master's Thesis, December, 1983.

M. S. Welch, "Numerical Analysis of the Elastic Shock Response of Installed Submarine Equipment," Master's Thesis, June, 1984.

T. R. Rentz, "An Experimental Investigation into the Dynamic Response of a Stiffened Flat Plate Loaded Impulsively by an Underwater Shockwave," Master's Thesis, June, 1984.

N. R. King, "Underwater Shock-Induced Responses of Stiffened Flat Plates: An Investigation into the Predictive Capabilities of the USA-STAGS Code," Master's Thesis, September, 1984.

Title: Optimal Control of Robotic Mechanisms

Investigators: D. L. Smith, Associate Professor of Mechanical Engineering and G. J. Thaler, Distinguished Professor of Electrical Engineering

Sponsor: NPS Foundation Research Program

Objective: To investigate the application of optimal control theory to the control of robotic mechanisms.

Summary: Modern optimal control theory is well suited to computer based controller design. An evaluation of candidate 'optimal' strategies will be conducted via dynamic simulation. The most promising strategy will be implemented in a computer based robot controller. The importance of key assumptions about nonlinear design performance will be investigated.

Thesis Directed: G. R. McGalliard, "A General Simulation Program for Robot Manipulator Arm Dynamics," Master's Thesis, September, 1984.

APPENDIX

<u>Summary Title</u>	<u>Investigator</u>	<u>Type Funding</u>
COMPUTER SCIENCE		
Methodology for the Formal Specification of Portable Software Interfaces	D.L. Davis	6.1
Top-Down Reasoning about Statistics on Databases	N.C. Rowe	6.1
The Effects of Real-Time Display Generation on the Architecture of Graphics Display Systems	M.J. Zyda	6.1
DEPARTMENT OF MATHEMATICS		
Research into Problems of Group Decision Theory and Information Pooling	G. Owen	6.1
DEPARTMENT OF ADMINISTRATIVE SCIENCES		
An Empirical Investigation of the Behavior of Reactive Control Systems	S.L. Ansari	6.1
Alternative Models of Corporate Capital Investment and their Implications for DoD Procurement	P. Bromiley D.C. Boger	6.1
Model Patternmatching in Model Management Systems	D.R. Dolk	6.1
An Evaluation of Leasing as a Financing Strategy within the Navy	J.G. San Miguel	6.2

<u>Summary Title</u>	<u>Investigator</u>	<u>Type Funding</u>
DEPARTMENT OF PHYSICS		
Radiation Effects on Infrared Detector Materials	K.C. Dimiduk F.R. Buskirk	6.1
Measurement of Acoustic Ambient Noise in the Cargo Bay of the Space Shuttle during Launch	R. Panholtzer S.L. Garrett O.B. Wilson A.E. Fuhs E.D. Ewing Y.S. Shin M.D. Kelleher	6.1
Parameterization of the Riso Puff Model for Complex Coastal Terrain	G.E. Schacher S. Larsen	6.2
Atmospheric Optics Instrumenta- tion and Measurements	D.L. Walters	6.1
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING		
Image Data Compression and Repre- sentation by Piecewise Surfaces Over Irregular Patches	C.H. Lee	6.1
Perturbative Model Analysis of the Back-Scattering Character- istics of a Missile over Several Frequency Bands	H.M. Lee	6.1
Inherent Tracking Errors of a Monopulse Radar	H.M. Lee	6.1
Acoustic Tactical Data Link	P.H. Moose	6.1

<u>Summary Title</u>	<u>Investigator</u>	<u>Type Funding</u>
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING (cont.)		
Propagation of Scalar Acoustic Waves	D. Guyomar J. Powers	6.2
Underwater Acoustic Propagation and Scattering in a Random Ocean -- A Linear Systems Theory Approach	L.J. Ziomek	6.1
DEPARTMENT OF METEOROLOGY		
Investigation of the Structure and Evolution of the Coastal ABL Using an Acoustic Doppler Sodar System	W.J. Shaw	6.1
DEPARTMENT OF AERONAUTICS		
The Influence of Spectrum Functions and Filters on the Crossing Frequency of Atmospheric Turbulence	J.V. Healey	6.1
Metallized Solid Fuel Ramjet Combustion	D.W. Netzer A. Gany	6.1
Wave Rotors and Wave Engines	R.P. Shreeve A. Mathur	6.1
DEPARTMENT OF MECHANICAL ENGINEERING		
C.A.E. (Computer Aided Engineering) with an APOLLO Computer	G. Cantin	6.1
Thermal Mapping of Turbulent Buoyant Jets Using a Micro-thermocouple Probe	W.G. Culbreth	6.1

<u>Summary Title</u>	<u>Investigator</u>	<u>Type Funding</u>
DEPARTMENT OF MECHANICAL ENGINEERING (cont.)		
Natural Convection in a Liquid Filled Enclosure with a Heated Protrusion	M.D. Kelleher	6.1
Underwater Shock Response of Submerged Structure	Y.S. Shin	6.1
Optimal Control of Robotic Mechanisms	D.L. Smith G.J. Thaler	6.1

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