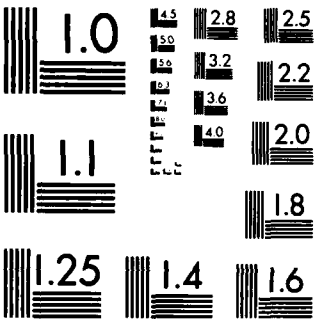
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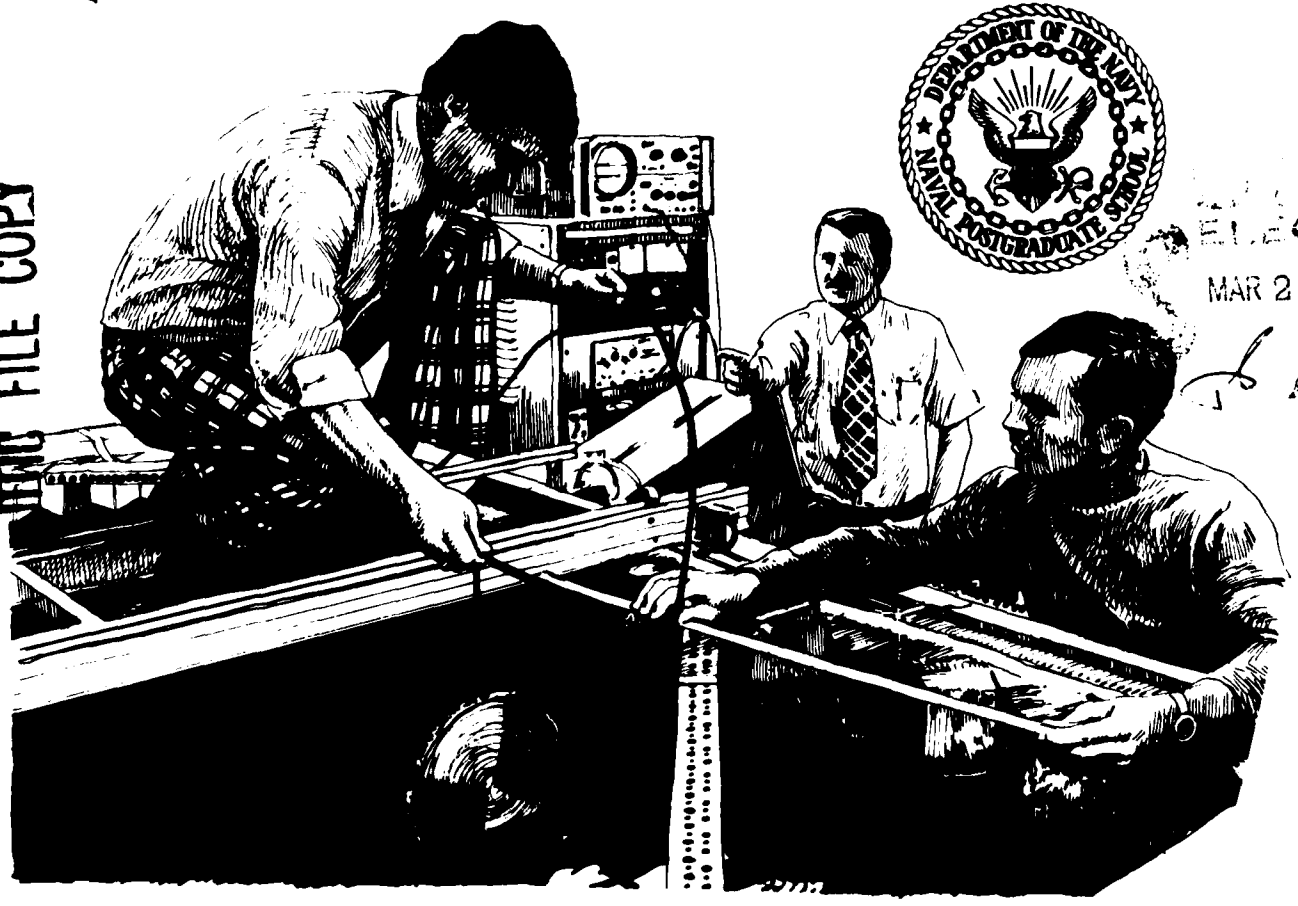
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REPORT FOR THE PERIOD
1 OCT 1982 TO 30 SEPT 1983

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

Commodore Robert H. Shumaker
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Naval Postgraduate School
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report contains 221 summaries on research projects which were carried out under funding to the Naval Postgraduate School Research Program. This research was carried out in the areas of Computer Science, Mathematics, Administrative Sciences, Operations Research, National Security Affairs, Physics, Electrical Engineering, Meterology, Aeronautics, Oceanography and Mechanical Engineering. The Table of Contents identifies the areas of research.

A SUMMARY OF RESEARCH ACTIVITIES

INTRODUCTION AND BACKGROUND

Research activities performed at the Naval Postgraduate School (NPS) during fiscal year 1983 are abstracted in this summary volume. These results are due to the efforts of principal investigators (faculty members at NPS) with, in most cases, student contributions through activity leading to a thesis in pursuit of an advanced degree.

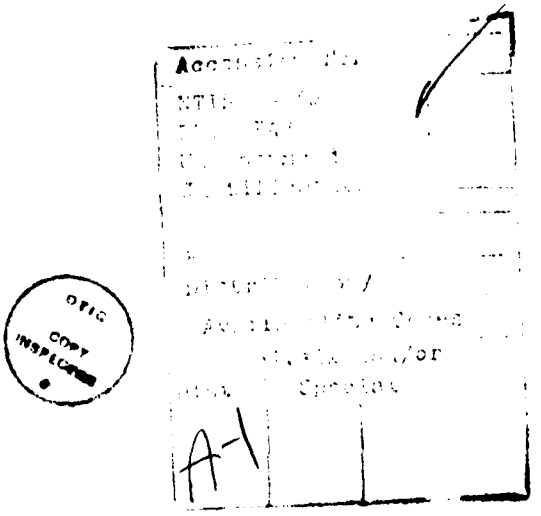
The importance of research at NPS is recognized in the mission Statement:

> ". . . to encourage a program of research in order to sustain academic excellence."

Research performed at an educational institution such as NPS provides not only the benefits of original investigations inherent in all research activities but, in addition, contributes to the knowledge base and vitality of the educational activities at the institution. Sponsor benefits include augmentation of research efforts with student activity, and exposure of students to areas of current concern.

The Naval Postgraduate School provides a unique interface between academic institutions and the Navy. As such, the research projects undertaken are, in general, clearly related to Navy and DOD interests. A substantially larger fraction of the R&D effort at NPS is in the exploratory development category than would be found in most universities. This is a result of student interests as well as faculty motivation created by the environment at NPS.

Support of NPS research activities has diversified to presently include more than sixty separate sponsoring agencies. The enclosed summaries indicate the level of activity and the diversity of efforts in support of both education and research.



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Title: Research on Database System Architecture and Benchmarking

Investigators: David K. Hsiao, Professor and Chairman of Computer Science and Douglas S. Kerr, Adjunct Professor of Computer Science

Sponsor: Office of Naval Research

Objective: To design, analyze and experiment on a multi-backend database system, known as MDBS and to develop a methodology for benchmarking database systems.

Summary: Our research on the software and hardware architectures of the multi-backend system has resulted in a system with one controller backend (i.e., the master) and several parallel backends (slaves). The system allows the addition of more backends of the same type (instead of replacement of the present backends with more powerful and expensive models), requires identical software in each of the backends, replicates the existing software on new backends, and minimizes the role of the controller of the backends. The design, analysis and implementation of the multi-backend database system has been completed in the past fiscal year, representing a significant contribution towards the availability of such a system for the study of performance gain and capacity growth. The notion of extensibility utilizing replicated software and identical hardware without controller limitation is the highlight of the research result. The system, known as MDBS, is operational and demonstrable.

The lack of a methodology for benchmarking database systems is well known. Without such a methodology a realistic evaluation of database systems is not possible. The proliferation of database systems in recent years accentuates the acute need of such a methodology. As a first step, we have concentrated our research on a methodology for benchmarking the relational database machines. The discovery and completion of this methodology is the most important result of our research so far. It is hoped that we can generalize the methodology for benchmarking our multi-backend database system (MDBS) in the future.

Title:	Software Support Maintenance
Investigator:	G. H. Bradley, Professor of Computer Science
Sponsor:	Naval Air Systems Command
Objective:	Survey NAVAIR software maintenance activities to identify research needs to improve the maintenance of tactical embedded computer systems.
Summary:	The NAVAIR tactical aircraft software maintenance activities at the Naval Weapons Center, the Naval Air Development Center, and the Pacific Missile Test Center were surveyed to identify research needs to improve the effectiveness and efficiency of software support. The Workshop on Maintenance and Testing of Aviation Software was held at the Naval Postgraduate School on October 4-6, 1983 to develop a summary of software engineering research needs in the area of aviation software.
Theses Directed:	John E. Hall, II, "Documentation for Software Maintenance," Master's Thesis, December 1983. Robert Burton Upchurch, "Improvements to Software Maintenance Methods in Real Time Embedded Aviation Flight Systems", Master's Thesis, December 1983.

Title:	Computer Software Design
Investigator:	G. H. Bradley, Professor of Computer Science
Sponsor:	NPS Foundation Research Program
Objective:	Develop software tools to support the design and implementation of computer software systems for scientific computations.
Summary:	A comprehensive survey of software design methodologies for developing computer programs for scientific computations was completed. A program family of prettyprinters based on information hiding principles was designed and partially implemented. A computer software system to provide comprehensive checking of data input files was designed, fully implemented and tested. These tools are valuable to designers of scientific software systems.
Publications:	G. H. Bradley, "Check Program for FORTRAN Data Files" (in preparation).
Thesis Directed:	Tae Nam Ahn, "Program Family for Extended Pretty Printer", Master's Thesis, June 1983.

Title:	Distributed Deadlock Detection in Distributed Computing Systems
Investigator:	D. Z. Badal, Associate Professor of Computer Science
Sponsor:	NPS Foundation Research Program
Objective:	To investigate deadlock detection in distributed computing systems
Summary:	The new more efficient distributed deadlock detection algorithm was invented.
Publications:	Badal, D. Z. and M. T. Gehl. "On Deadlock Detection in Distributed Computer Systems," Proceedings of the Second Joint Conference of the IEEE Computer and Communication Societies, INFOCOM83, San Diego, April 10-21, 1983, 36-49. Badal, D. Z., and M. T. Gehl. "On Robustness of Deadlock Detection Algorithms for Distributed Computing Systems," Proceedings of the Second International Conference on Computer Science, Santiago, Chile, August 1982.
Conference Presentation:	INFOCOM83, San Diego, April 19-21, 1983.
Thesis Directed:	M. T. Gehl, "Deadlock Detection in Distributed Computing Systems," Master's Thesis, December 1982.

Title:	Adaptive Synchronization for Distributed Databases
Investigator:	D. Z. Badal, Associate Professor, Computer Science Department
Sponsor:	Naval Ocean System Center
Objective:	To investigate adaptive concurrency control for distributed databases
Summary:	The new method of synchronization or concurrency control was invented. This method has a superior performance with respect to existing concurrency control mechanisms.
Publications:	D. Z. Badal and McElyea, W. "A Robust Adaptive Concurrency Control for Distributed Databases," Proceedings of the Third Joint Conference of the IEEE Computer and Communication Societies, INFOCOM84, San Francisco, April 9-12, 1984.
Thesis Directed:	J. E. Vesely and J. C. White, "Concurrency Control in Distributed Systems with Application to Long-lived Transactions and Partitioned Networks," Master's Thesis, June 1983.

FUNCTIONAL PROGRAMMING

B. J. MacLennan has continued the development of the theory and practical methodology for advanced software development. The research has involved the development and comparison of formal models of systems, the development of a method of determining the major structural components of programming languages, a demonstration of the use of relational calculus operators in very high level languages, and an investigation of tools to enhance the development and maintenance of software.

MAN-MACHINE INTERFACE

G. A. Rahe and his thesis students have developed networked workstations for military commanders. The aim is to develop tests which can measure the effectiveness of the workstations.

MULTI-MICROCOMPUTER ARCHITECTURE

U. K. Kodres, M. L. Cotton, R. Panholzer and their thesis students have continued their study of the use of very-large-scale-integration technology in the SPY-1A radar control. The research involves hardware interface development using fiberoptics, implementation of skeletal weapons control systems interface and command and decision interface, and system's programming and performance analysis.

SOFTWARE METRICS

B. J. MacLennan, his research associate, and thesis students have continued their work on foundations for software metrics and on the use of some of these metrics for measuring programming languages. The aim is to produce testable and applicable theories for programming language metrics.

DEPARTMENT OF COMPUTER SCIENCE

The research in the Computer Science Department consists of student thesis work and faculty research in the core areas of computer science and in the novel use of computer systems for Navy high-tech applications. The Departmental research efforts have allowed the development of extensive research facilities that feature microcomputers, minicomputers, computer graphic devices, image and signal processing equipment, workstations, personal computers, and database computers.

BENCHMARKING OF DATABASE MACHINES AND SYSTEMS

D. K. Hsiao, P. Strawser and four thesis students have been using a benchmarking methodology developed by Strawser to evaluate a database machine leased by the Naval Pacific Missile Test Center. The aim is to verify and apply the benchmarking methodology for evaluating the performance of relational database machines and systems at large.

COMPUTER SOFTWARE DESIGN

G. H. Bradley and his thesis students have designed and implemented a program family of pretty-printers based on information hiding principles. The aim of this research is to develop software tools to support the design and implementation of computer software systems for scientific computations.

DATABASE SYSTEM KERNEL

D. K. Hsiao, D. S. Kerr, S. Demurjian, and P. Strawser and eight thesis students are studying the use of a multi-backend system as a database kernel to support many data models and languages by way of software interfaces. The aim is twofold. First, they study the complexity of supporting relational, hierarchical and codasyl interfaces. Second, they study the performance and capacity issues of the database kernel.

DEPARTMENT

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R. D. Boyne, D. K. Hsiao, D. S. Kerr and A. Orooji, "A Message-Oriented Implementation of a Multi-backend Database System (MDBS)", Database Machine, Springer-Verlag, 1983, pp. 242-266.

M. J. Menon and D. K. Hsiao, "Design and Analysis of Join Operations of Database Machines", Advanced Database Machine Architecture, Prentice-Hall, 1983, pp. 203-255.

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X. G. He, M. Higashida, D. S. Kerr, A. Orroji, Z. Z. Shi, P. R. Strawser and D. K. Hsiao, "The Implementation of a Multi-backend Database System (MDBS): Part II - The Design of a Prototype MDBS", Advanced Database Machine Architecture, Prentice-Hall, 1983, pp. 327-385.

D. K. Hsiao, "Cost-Effective Ways of Improving Database Computer Performance", AFIPS Conference Proceedings, V. 52, (May, 1983), pp. 293-298.

R. D. Boyne, S. A. Demurjian, D. K. Hsiao, D. S. Kerr and A. Orroji, "The Implementation of a Multi-backend Database System (MDBS): Part III - The Message Oriented Version with Concurrency Control and Secondary Memory-Based Directory Management", NPS Technical Report, NPS52-83-003, March 1983.

Conference Presentation:

D. K. Hsiao, "A Multi-backend Database System", the 3rd International Workshop on Database Machines, Munich, West Germany, September 28, 1983.

D. K. Hsiao, "Benchmarking Database Machines - A Methodology", at the 3rd International Workshop on Database Machines, Munich, West Germany, September 26, 1983.

D. K. Hsiao, "Database Machine Research", at NAVDAC Workshop on Database Machines, September 16, 1983.

D. K. Hsiao, "Database Machines - A Brief Tutorial", at the Federal Computer Conference, Washington, D.C., September 15, 1983.

D. K. Hsiao, "Database Systems and Machines - A Short Course", at National Taiwan University, Information Engineering Department, Taipei, Taiwan from July 14 until July 22, 1983.

D. K. Hsiao, "Database Computers - A Perspective", at NAVDAC Workshop on Database Machines, Pt. Mugu, CA, May 17, 1983.

D. K. Hsiao, "Cost-effective ways of Improving Database Computer Performance", at National Computer Conference, Anaheim, CA, May 16, 1983.

Thesis Directed:

M. Crocker, Benchmarking the Join Operation of a Relational Database Machine, M. S. Thesis, Naval Postgraduate School, Monterey, CA, June 1983.

R. Bogdanowicz, Benchmarking the Selection and Projection Operations, and Ordering Capabilities of Relational Database Machines, M. S. Thesis, Naval Postgraduate School, Monterey, CA, June 1983.

C. Ryder, Benchmarking Relational Database Machine Capabilities in Supporting the Database Administrators' Functions and Responsibilities, M. S. Thesis, Naval Postgraduate School, Monterey, CA, June 1983.

V. Stone, Design of Relational Database Benchmarks, M. S. Thesis, Naval Postgraduate School, Monterey, CA, June 1983.

Title: Emulation of a Multi-microcomputer Architecture for the SPY-1A Control Computer

Co-Investigators: Uno R. Kodres, Professor of Computer Science, Mitchell Cotton, Professor of Electrical Engineering Department, and Rudolf Panholzer, Professor of Electrical Engineering Department

Sponsor: PMS 400, Daniel Green, Naval Surface Weapons Center, Code N20E, Dahlgren, VA 22449

Objective: To explore the use of large scale integrated circuit technology in order to control the SPY-1A radar. A multimicrocomputer emulation of the functions of the SPY-1A control computer will be carried out, in order to determine the feasibility of such an approach.

Summary: This project is a continuation of an ongoing project which was summarized in past reports. This year, the sequence of projects related to the INTEL 432/670 system has determined that the 432 system can successfully operate in the multiprocessor mode with up to five processors without losing performance because of the system's bus congestion. This finding was surprising and due to a very efficient system's bus. Because of the multiprocessor capability, the iAPX 432/670 system will be able to out-perform the military standard mini computers. The AN/UYK-20 and AN/AYK-14.

In the operating sytems area, the major advance was to create a four-user CPM86 system which enables the single board computer to be dedicated to workstation designed for both program development and real-time multiprocessor applications. Also a 10 megabit/sec ethernet interface has been created for connecting the VAX 11/780 into a local area network with microcomputer laboratory.

In the SPY-1A radar controller applications area, a hard disk unit was used to simulate the radar signal processor. Another advance was to connect the multi-single-board computer system to the display subsystem with a high speed parallel interface. The software support for the data passing mechanism allows the display subsystem to keep up with the rapidly updated data elements in the multiprocessor system.

Publication: U. R. Kodres, "Processing Efficiency of a Class of Multicomputer Systems", International Journal of Mini and Microcomputers (accepted for publication)

Thesis Directed:

The INTEL 432/670 and ADA Performance Benchmarks. David J. Applegate and Rober A. Coates, M.S. Computer Science, December 1982.

Alteration and Implementation of the CP/M-86 Operating System for a Multi-user Environment. Thomas V. Almquist and David S. Stevens, M.S. Computer Science, December 1982.

Signal Processor Interface Simulation of the AN/SPY-1A Radar Controller. Todd B. Kersh, M.S. Computer Science, June 1983.

INTEL ¥32/670 ADA Benchmark Performance Evaluation in the Multiprocessor/Multiprocess Environment. Theodore F. Rogers Jr. and Ioannis A. Karadimitropoulos. M.S. Computer Science, June 1983.

Design and Implementation of Software Protocol in VAX/VMS Using Ethernet Local Area Network, Thawip P. Netniyom. M.S. Computer Science, June 1983.

Implementation of a Parallel Message Passing Interface Between Single Board Computers. Gary J. Magnuson, M.S. in Engineering Science, September 1983.

A Layered Communications System for Ethernet. Mark D. Stotzer, M.S. in Electrical Engineering, September 1983.

Title: Programming Language Metrics

Investigator: Bruce J. MacLennan, Associate Professor of Computer Science

Sponsor: Office of Naval Research

Objectives: Since programming languages are the primary tools used in the programming process, it is not surprising that the choice of programming language is an important element of the life-cycle cost of a software development project. To make this choice, it is necessary to be able to compare languages and judge their suitability for various applications. Programming languages are frequently compared informally. One language may be described as more "structured" than another, or simpler, or more powerful, or better "human engineered", or less procedural, or smaller, or more "orthogonal", and so forth. These claims are particularly common in the descriptions of new programming languages.

Unfortunately, there do not exist objective methods for validating these claims. A claim that one language is preferable to another may be supported by arguments, but these are frequently unconvincing. Also, these arguments fail to provide any quantitative measure of how languages compare along these axes. This eliminates any meaningful evaluation of the tradeoffs among language design decisions. Thus, language comparison and evaluation remains a mostly subjective art, not unlike literary criticism. This is unsatisfactory for a tool of the importance of a programming language.

Summary: This project involves research on three different fronts: (1) validation methods and epistemological foundations for programming language metrics, (2) theoretical definition and investigation of the properties of these metrics, and (3) practical tools for measuring programming languages. Progress has been made on all three fronts this year.

First, several tools have been developed to aid in this work. We have developed a tree-transformation system that allows the expression of simple tree and string transformation rules. Several different transformation strategies have been evaluated, both empirically and analytically. This system will simplify writing algorithms to reduce grammars to various normal forms and will allow the automatic measurement of grammar size and other properties.

Grammers can be compared on the basis of their rate of string generation. Unfortunately, for the grammars that occur in real programming languages, the resulting generating functions are too complicated to be solved analytically. Therefore, we have also developed software to permit the numerical investigation of the rate of string generation of programming language grammars.

We have shown that our grammar-based metrics satisfy a number of properties they would be expected to satisfy (additivity, independence of primitive notions, etc.). This indicates that the formal metrics agree with corresponding informal notions. We have also investigated the theoretical connections between metrics based on translation grammars and tree transformation rules.

Finally, we have investigated the validation of metrics like those defined above. We have determined that these metrics must be validated by their integration with existing theories and by their usefulness, rather than by psychological demonstrations of their relationship with preceived qualities. As it has in the natural sciences, the objective approach is more likely to produce testable, widely applicable theories than is the subjective approach.

Publications:

B. J. MacLennan, Principles of Programming Languages: Design, Evaluation, and Implementation, Holt, Rinehart and Winston, 1983, 544 pages.

B. J. MacLennan, Functional Programming: Theory and Practice, book in preparation, 1984 publication anticipated.

B. J. MacLennan, "Simple Metrics for Programming Languages", Information Processing and Management, forthcoming.

B. J. MacLennan, "Measuring Control Structure Complexity Through Execution Sequence Grammars", submitted for publication.

B. J. MacLennan, "A Simple, Natural Notation for Applicative Languages", SIGPLAN Notices 17, 10, October 1982.

B. J. MacLennan, "Values and Objects in Programming Languages", SIGPLAN Notices 17, 12, December 1982, pp. 70-79.

B. J. MacLennan, "Overview of Relational Programming", SIGPLAN Notices 18, 3, March 1983, pp. 36-45.

B. J. MacLennan, "Abstraction in the Intel iAPX-432 Prototype Systems Implementation Language", SIGPLAN Notices, forthcoming.

B. J. MacLennan, "A View of Object-Oriented Programming", submitted for publication.

B. J. MacLennan, "Simple Metrics for Programming Languages", Naval Postgraduate School Technical Report NPS52-82-010, October 1982, 29 pages.

B. J. MacLennan, "A View of Object-Oriented Programming", Naval Postgraduate School Technical Report NPS52-83-001, February 1983, 54 pages.

B. J. MacLennan, "Abstraction in the Intel iAPX-432 Prototype Systems Implementation Language", Naval Postgraduate School Technical Report NPS52-83-004, April 1983, 26 pages.

B. J. MacLennan, "A Computer Science Version of Godel's Theorem", Naval Postgraduate School Technical Report NPS52-83-010, August 1983, 15 pages.

B. J. MacLennan, "Concurrency and Synchronization in the Intel iAPX-432 Prototype Systems Implementation Language", Naval Postgraduate School Technical Report NPS52-83-011, September 1983, 27 pages.

B. J. MacLennan, "Relational Programming", Naval Postgraduate School Technical Report NPS52-83-012, September 1983, 72 pages.

B. J. MacLennan, "A Commentary on Mill's Logic Book 1: Of Names and Propositions", Naval Postgraduate School Technical Report in progress, 50 pages.

B. J. MacLennan, "Tree Transformations for Functional Programming", Naval Postgraduate School Technical Report, in progress.

B. J. MacLennan, "In What Sense is Computer Science a Science?", Naval Postgraduate School Technical Report, in progress.

Presentations: B. J. MacLennan, "A Simple Metrics for Programming Languages", Symposium on Empirical Foundations of Information and Software Science, November 3-5, 1982.

B. J. MacLennan, "Relational Programming", Engineering and Applied Science Seminar, University of California at Davis (Livermore), November 18, 1982.

B. J. MacLennan, "Relational Programming", Stanford University Computer Science Colloquium, May 3, 1983.

Title: C^2 Workstations

Investigator: G. A. Rahe, Professor of Computer Science, Alan Ross, Assistant Professor of Computer Science, D. Dolk, Assistant Professor, Management Science, and Chin-Hwa Lee, Assistant Professor of Electrical Engineering

Sponsor: NAVELEX

Objective: Develop networked workstations for military commanders

Summary: The first six months of this three year program has been devoted to establishing a disciplined structure that will lead to measureable tests. Hardware and software evaluations and procurements have been accomplished and interested researchers enlisted. The program will be employing expert system techniques to make the workstations easy to learn and to use.

Title:	Design Automation Workbench
Investigator:	Alan A. Ross, Lt. Col., USAF
Sponsor:	NPS Foundation Research Program
Objective:	Install the Computer System Design Environment at NPS, and acquire and integrate a bit-mapped display with the rest of the design system.
Summary:	The objectives have been met. We purchased an AED 767 Video display, installed CSDE on the Computer Science Department VAX 11/780, and a student is just finishing the display integration.
Publication:	Bowers, Jeanne and Alan A. Ross, "Computer System Design Environment Software Development Plan," NPS Technical Report, July, 1983.

Title:	Algorithm Design
Investigator:	D. S. Smith, Associate Professor of Computer Science
Sponsor:	NPS Foundation Research Program
Objective:	To continue the development of approach to automatic algorithm design with a focus on greedy algorithms.
Summary:	Develop a theory of the structure of greedy algorithms from specifications, to formulate, program and test mechanisms for automating these derivations.
Publications:	Smith, Douglas R., "The Structure of Divide and Conquer Algorithms," NPS52-83-002, Technical Report, March 1983.

DEPARTMENT

OF

MATHEMATICS

DEPARTMENT OF MATHEMATICS

The Mathematics Department has had a long standing concern for scholarship and for education. The department is justly proud of the past successes of its members and is looking forward with keen anticipation to the areas where it can make a significant impact in the future. One of these areas has to do with the recent rapid development of the microcomputer. The department has established a microcomputer laboratory and has made strides toward incorporating the use of the microcomputer in the classroom where it has proved to be an effective teaching aid.

Besides the work with microcomputers, the members of the department continue their development in other scholarly pursuits. In this way, the Mathematics Department continues to be a valuable service organization available to the various curricula represented at NPS.

NUMERICAL ANALYSIS

Numerical analysis continues to be a major focus for the research efforts of the members of the department. R. H. Franke continues to study surface approximations from scattered data points. This work on scaling data on surfaces with sharp gradients with G. M. Nielson of Arizona State University has resulted in three papers and several series of lectures. Professor Franke also has been studying optimum interpolation schemes for meteorological data with W. Gordon of Drexel University.

Professor T. Jayachandran has joined Franke to continue their studies of the properties of a new goodness-of-fit test. Their research has resulted in several papers and tables of application of their test.

Professor A. L. Schoenstadt continues his work on numerical weather prediction in oceanography. He is also interested in new algorithms to be applied to the new architectures in VLSI computers. These areas of research have also been investigated by Professor R. Mendez who has been making studies of the large-scale computers which have been appearing recently. Professor H. M. Fredricksen has been studying the algorithms that can be applied to the systolic array architectures.

MICROPROCESSOR LABORATORY

The microprocessor lab serves as the focus for several members of the department for research opportunities, as well as for course development. Professor G. Latta, while developing the laboratory and courses that support its operations, has overseen theses on networking applications and a menu driven modem program to interface with the IBM 3033 computer which operates appreciably faster than any commercially available programs.

STATISTICAL ANALYSES

T. Jayachandran continues with H. Larson to provide statistical support for an Air Force oil analysis program which helps spot wear-metal buildups. They also have been conducting proficiency studies which allow the scoring and ranking of technicians. These studies have resulted in several papers. Together with R. H. Franke, he has been studying the problem of choosing a size for Student's t-test.

Professor Jayachandran has also been working on the problem for finding prediction intervals for normal samples and prediction intervals for first-order Gauss-Markov processes.

DISCRETE MATHEMATICS

Discrete mathematics can be applied to the problem of finding good codes for communications purposes and for analyses of communications systems. H. M. Fredricksen has been considering several problems which have their application in secure communications channels and cryptographic purposes. The papers resulting from these studies appear in the classified literature. Together with R. L. Ward of the Department of Defense, Professor Fredricksen has been studying the properties of irreducible polynomials over finite fields.

OPTIMIZATION

I. B. Russak continues his work on the convergence of non-linear optimization algorithms under weakened hypotheses. These weakened hypotheses more realistically represent real world applications.

SIGNAL PROCESSING

Professor J. Wayman has been using microprocessors in the area of acoustic signal processing, developing new methods for measuring the acoustical properties of materials.

Title:	Investigation of Objective Analysis Schemes
Investigator:	Richard Franke, Associate Professor of Mathematics
Sponsor:	Naval Environmental Prediction Research Facility
Objective:	To investigate properties of schemes which are used, or can be used, to interpolate or approximate scattered data from meteorological sources.
Summary:	Investigation of the properties of optimum interpolation schemes has continued. These kinds of schemes have arisen in diverse fields independently and have been shown to be equivalent. The functional form of the approximation and how the method accounts for errors of varying magnitudes has been developed. The effects of errors in the interpolation of calculated grid values to the observation points is under investigation. A methodology for simulation of the objective analysis process has been developed and is being used to determine the contribution of errors from various parts of the overall scheme. This methodology will be used to test skill vs. cost for analogs of various objective analysis schemes.
Publication:	"The Structure of Optimum Interpolation Functions", TR # NPS-53-83-005, with W.J. Gordon.

tle: Enhancement of Effectiveness of RDT&E Investments of the Naval Facilities Engineering Command

vestigator: J. W. Creighton, Professor, Department of Administrative Sciences.

onsor: NAVFAC

jectives: The continuing general objective of the project has been to accelerate the rate of adoption of NAVFAC generated technology and new technology derived from other sources. Various approaches have been explored in the past, but the concentration in FY-1983 was to explore means by which Managerial and Financial Control devices and regulations might be administered so as to encourage the rate of technology trial and acoption.

mmary: Extensive interviewing was performed with executive and middle management personnel from military and other government organizations and from the private sector. Results indicated generally that there is almost unanimous belief that the various control devices are needed, but that a great variation exists in the form of application. As a consequence, the control system may be percieved as a barrier to innovation when administered by one manager, but a stimulator when administered by another.

The interviews have resulted in effort to provide guidelines for managers to use control devices as encouragers of innovation. A symposium on this effort was scheduled for February, 1984, sponsored by NAVFAC and the U.S. Forest Service Proceedings of the symposium will be published in 1984.

esis Directed: Martin, J.A., "Control Systems". Master's Thesis, December 1983.

Title: The Internal Allocation of Corporate Capital

Investigator: Philip Bromiley, Assistant Professor, Department of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To increase understanding of the factors influencing the allocation of corporate resources across alternative corporate business areas.

Summary: The research program has three main thrusts. First, actual allocation procedures in corporations are investigated by (a) interviews with corporate employees involved in capital allocation, (b) modelling of allocation processes, and (c) estimation of models. Second, alternative models of the level of corporate capital investment are being compared on the basis of prediction (with Dan Boger). Third, parsimonious explanations for empirical results on production functions are being explored (with Herbert Simon).

Publications: "The Determinants of Corporate Capital Investment: A Behavioral Approach," submitted to the Journal of Economic Behavior and Organization.

"A Comparison of Behavioral and Neo-Classical Conceptions of Investment," submitted to the Journal of Economic Behavior and Organization.

"Planning Systems and Corporate Behavior: A Process Approach," submitted to Strategic Management Journal.

A Behavioral Investigation of Corporate Capital Investment, forthcoming book to be published by Cambridge University Press.

Spooner, Daniel, "Programmer Productivity Metrics", Master's Thesis, December 1982.

Title: Productivity Enhancement Study of FMSO Information Processing Facilities

Investigator: Dan C. Boger, Assistant Professor of Economics, and

Norman R. Lyons, Associate Professor of Information Systems

Sponsor: Fleet Material Support Office

Objective: To study productivity enhancing measures that could be applied to the software development effort at FMSO.

Summary: A number of productivity enhancing measures were identified and discussed. The major thrust of the report was the suggestion that FMSO set about acquiring a machine to use as a software development tools system.

Publications: "A Productivity Enhancement Study of the FMSO Software Effort" NPS Technical Report, NPS-54-83-013, November 1983.

Boger, Dan C., Jones, Carl R. and Lyons, Norman R.,"Improving Information Systems Management: Technological Opportunities and Social Constraints", Proceedings of the Fourth International Conference on Information Systems, Houston, Texas, December 1983.

Conference Presentation: "Social Equity in Computer Management: The Federal Government Dilemma", TIMS/ORSA Conference, San Francisco, May 14, 1984.

Thesis Directed: Conroy, James, Fuqua, Michael and Sisco, Julius, "A Survey of Software Quality Assurance Standards With Specific Applications to the Fleet Material Support Office Quality Assurance Program", Master's Thesis, December 1982.

Corcoran, Mimi and Macmillan, Denham, "Analysis of Productivity Enhancement Through Nonprocedural Languages", Master's Thesis, December 1982.

Delorenzo, James and Larue, Stephen, "A Comparative Analysis of DOD Computer Systems Acquisition Costs to the Private Sector", Master's Thesis, March 1984.

Title:	Overhead Cost Management and Control
Investigator:	D. C. Boger, Assistant Professor, Department of Administrative Sciences
Sponsor:	Naval Air Systems Command and Navy Office of Acquisition Research, Naval Material Commmand
Objective:	To develop descriptive and analytical models of the composition of overhead costs, overhead cost pools used, related allocation bases, and volume levels at which allocation rates are established at two NAVAIR contractors.
Summary:	In conjunction with a team of personnel from NAVAIR and the relevant NAVPRO's, a consistent costing methodology was prepared to be used across contractors. Descriptive models of both contractors' accounting systems were prepared and statistical models of overhead costs were developed. Both structural and predictive models were evaluated. It was shown that excellent statistical models existed for total overhead costs and labor-related overhead costs.
Publications:	D. C. Boger, "Statistical Models for Estimating Overhead Costs," NPS Technical Report, NPS-54-83-014, October 1983. D. C. Boger, "Statistical Models for Estimating Overhead Costs," Engineering Costs and Production Economics, forthcoming.
Theses Directed:	F. J. Becker, Jr., "An Investigation into the Level of Compensation in the Aerospace Industry," Master's Thesis, June 1983. D. W. Stevens, "An Analysis of Overhead in the Aircraft Industry," Master's Thesis, June 1983.

MANPOWER/PERSONNEL/TRAINING RESEARCH

R. S. Elster began implementation of a program of research development which is designed to lead to the establishment of a Manpower Research Center at NPS. To this end, a number of new research faculty were added and the existing program of research broadened. M. J. Eitelberg and Professor Elster began a major project on applying a quantitative approach to the development of an enlistment suitability index for the U.S. Navy and U.S.M.C. M. Eitelberg and J. Goral examined the feasibility of personnel security screening using psychological techniques. M. Eitelberg and P. Hoffman studied the relationship between enlistment standards and youth participation in the All Volunteer Force. N. Nieboer began two projects; one aimed at development of a comprehensive information system covering all secondary schools for use in improving Defense high school testing and recruiting programs; the second, involved an in depth evaluation of the Defense high school testing program. Professor G. Thomas began a project to assess the feasibility of modeling the supply of older age accessions. Professor Thomas continued his work on the development of models of careerist retention behavior. Professors Thomas and Liao also studied the impact of economic factors on the reenlistment decisions of career petty officers. R. A. Weitzman continued his research on the application of sequential aptitude testing for recruit selection and assignment and his research into development of predictive techniques useful in manpower/personnel research. Professor T. G. Swenson began work on developing a theoretical model for understanding recruiting source characteristics and their organizational consequences. Professor B. Bloxon worked to develop practical methods for analyzing and comparing human performance time distributions.

ORGANIZATIONAL SCIENCES

C. K. Eoyang, R. T. Harris, R. McGonigal and W. R. Bishop continued the long term research program in organization development. Their extensive field work underlies significant contributions of the revitalization of the Navy's program in Human Resource Management/Organizational Effectiveness, which is the largenst in the country. M. R. Louis continued her research into the dynamics of career transitions and organizational culture. R. Evered continued his research in both the Strategic Management area and the epistemology of social science research. D. Whipple and J. LaPatra continued the investigation of the existence of an interdisciplinary predictive theory of intra-firm behavior. J. D. Senger continued his investigation of authoritarian attitudes among U. S. and allied military officers.

FINANCIAL/RESOURCE MANAGEMENT

Professor Whipple continued his work in the area of evaluation and analysis of the strucutre of the DoD Productivity Enhancement Program. Professors Boger and Whipple continued their investigation of the potential relationship between U. S. coal reserves and a "market-based" defense strategy. D. Boger, N. Lyons, and J. Hayes studied the productivity enhancement techniques at the Fleet Material Support Office's Information Processing facilities. K. J. Euske continued his research on the behavioral effects generated by the budgetary process. Professor Euske began a project examining the effects of alternative accounting methods on manpower costing. J. M. Fremgen and D. Boger began an effort to determine the classifications, composition and allocation of overhead costs in major aerospace defense contractors. Professor Fremgen examined the federal government's financial information needs and the relevance of depreciation to these needs. P. Bromiley continued his study of the determinants of corporate capital investment. S. S. Liao continued his study of the feasibility of using cost accounting and program accounting techniques to measure the performance of general governmental operations. Professors Liao and Greer began an analysis of sole source versus dual source system procurement of advanced weapons systems. Professor W. Greer continued his long-range research on the relationship between the structure of information and the quality of decision making. F. C. Horton began work on comparing the cost effectiveness of conventional versus computer-involved instructional techniques. Professor Perret continued her examination of the nature of adaptation of budgeting systems to different environments.

DEPARTMENT OF ADMINISTRATIVE SCIENCES

The Administrative Sciences Department is the Naval Postraduate School's organizational unit responsible for academic programs designed to educate officers and DoD civilians in a variety of functional management specialties. As such, it is a large, multi-disciplinary department with diverse research projects oriented to support management tasks within the Navy and the Department of Defense. For ease of exposition the research program may be divided into the following (sometimes overlapping) areas of research concentration: Acquisition, Information, and Logistics Systems; Organizational Sciences; Financial/Resource Management; and Manpower, Personnel and Training. The past year's focus of the specific research projects in these areas is summarized in the following paragraphs.

ACQUISITION, INFORMATION, AND LOGISTICS SYSTEMS

D. C. Boger, C. R. Jones, and K. Sontheimer (University of Pittsburgh) continued their research into the behavior of defense contractors and the peculiarities of this industry structure for defense internal firm organization and financial performance. M. B. Kline continued his research in systems engineering and the systems acquisition process areas, including analysis of maintainability, active repair time, and suitability of logistics provisioning, level of repair, and life support cost models for optimizing logistics resources. N. Lyons continued working on man-machine interface problems in the C3 area. N. F. Scheidewind continued his research in the areas of software engineering and management, and his involvement in the design of computer-communications networks in support of Naval supply systems. R. Weissinger-Baylon continued his research on problem solving and decision making. A. W. McMasters continued his research on methods to assist the Naval Electronic Systems Command in determining when to transfer control of inventories of items to the Ships Parts Control Center. Professor McMasters, in conjunction with Professor Bodin (Operations Research), also continued work on the development of an improved local delivery system for Naval Supply Centers at Oakland and Norfolk. Professor McMasters, in conjunction with R. Richards and G. Howard (OR), developed and evaluated uniform provisioning criteria for FMSO. J. W. Creighton continued his research on the technology transfer process. Professor W. H. Cullin continued his applied work in support of DoD acquisitions, planning, and management. D. R. Dolk initiated a project to study the applicability of "Artificial Intelligence" techniques to design and develop generalized software systems to solve complex math programming models. Professor San Miguel extended his work to include a field study to determine the impact of organizational constraints on design and implementation of Management Information Systems (MIS).

DEPARTMENT

OF

ADMINISTRATIVE SCIENCES

Title:	Computerized Acoustic Impedance Measurement System
Investigator:	James L. Wayman, Adjunct Professor of Mathematics
Sponsor:	NPS Foundation Research Program
Objective:	To furnish the NPS acoustics lab with a system for the measurement of normal acoustic impedance using the Seybert-Ross technique, to validate the system, and to conduct basic research on improving this method of fixed-microphone impedance measurement.
Summary:	The NPS acoustics lab has been equipped with a system using both the Seybert-Ross and the Chung-Blaser methods for measuring normal acoustic impedance in air. Additionally, a water-filled "gun barrel" has been constructed for extending the methods to the underwater environment.
Publications:	Wayman, J.L., "New Methods of Measuring Normal Acoustic Impedance", NPS Technical Report, NPS-53-84-0005.
Conference Presentations:	Invited Paper: "New Methods of Measuring Normal Acoustic Impedance", 105th Meeting of the Acoustical Society of America, Cincinnati, May 1983. Contributed Papers: "Comparison of Impedance Measurement Techniques", Mason, J.T. et al, 106th Meeting of the Acoustical Society of America, San Diego, November 1984. "Effect of Sealants of the Sound Absorption Coefficients of Acoustical Friable Insulating Material", Lory, M.K. and Wayman, J.L., 106th Meeting of the Acoustical Society of America, San Diego, November 1984.
Thesis Directed:	J.T. Mason, "Comparison of Impedance Measurement Techniques", Master's Thesis, December 1984.

Title:	Numerical Study of Viscous Flow Past Tense Flexible Boundaries.
Investigator:	R. Mendez, Assistant Professor of Mathematics
Sponsor:	NPS Foundation Research Program
Objective:	To develop and test numerical techniques to study the dynamics of vortex sheets.
Summary:	The study of uniform flow past a tense leaflet is of manifest importance to Cardiac Fluid Dynamics. This flow is computed numerically by resolving the vortex sheet along the boundary into a collection of discrete vortices with time-dependent strenghts. The dynamics of the flow can be recovered from that of the vortices along the boundary. Vortex shedding is easily incorporated into the model.
Publications:	Mendez, Raul and Burych, Donna, "Numerical Study of a one-dimensional Tense, Inextensible, Flexible Leaflet". Naval Postgraduate School Report Number NPS-53-83-ØØØ9 (December 1983). Mendez, Raul and Peskin, Charles, "A Numerical Method for High Reynolds Number Flow Past a Flexible, Inextensible Leaflet under Tension". Submitted to the SIAM Journal of Stat. and Sci. Comp.
Conference Presentation:	"A Numerical Method for high Reynolds Number Flow Past a Flexible, Inextensible Leaflet under Tension", presented at the Los Alamos Workshop on Vortex Methods, February 22, 1984.

Title: The Japanese Supercomputer Challenge

Investigator: Raul H. Mendez

Sponsor: NPS Foundation Research Program

Objective: To investigate the newly introduced Japanese Supercomputers. The machines to be introduced in the Fall of 1983 have announced Peak Speeds exceeding those of the current US supercomputers. He review the hardware and software features of these machines as well as the research National projects which resulted in the development of these supercomputers. The possible impact of the Japanese initiative on the US computer market is also investigated.

Publication: R. H. Mendez, "The Japanese Supercomputer Challenge", Siam news, Volume 17, numberl/January 1984.

Conference: R. H. Mendez, "The Japanese Supercomputer Chalenge", Mathematics colloqum at NPS and National Defense Academy, Yokosuka, Japan; Fall 1983.

Title: Mathematics Research Chair and Conference on Elliptic Problem Solving

Investigators: Toke Jayachandran, Associate Professor of Mathematics, and Arthur L. Schoenstadt, Associate Professor of Mathematics

Sponsor: Office of Naval Research

Objective: To support Professor Garrett Birkhoff while he occupied the ONR Chair in Mathematics at the Naval Postgraduate School, and, in conjunction with this, to conduct a three-day conference on recent developments in the state of the art of software for solving elliptic partial differential equations.

Summary: Professor Birkhoff occupied the Mathematics Chair during AY 82-83. During this time he presented a seminar course in numerical fluid dynamics, and also completed lecture notes in that subject. The Elleptic Problem Solvers Conference as held at NPS during January 10-12, 1983, and was attended by approximately 120 mathematicians and scientists from the United States and Europe. Approximately forty papers were presented at the conference.

Publications: G. Birkhoff and A. L. Schoenstadt (editors), Elliptic Problem Solvers II, Academic Press, New York (to appear)

G. Birkhoff, Numerical Fluid Dynamics, lecture notes, 240pp

Title:	Project SALESCLERK: Application of Shift Register Sequences to Problems of Communications
Investigator:	Harold M. Fredricksen, Associate Professor Department of Mathematics
Sponsor:	National Security Agency
Objective:	To perform analyses of shift register sequences to include their generation, properties and capabilities for communications applications. To perform a critical analysis of documents provided by the sponsor.
Summary:	The investigator continued the study of a class of shift register sequences - full sequences. In particular, a solution to the logarithm problem was found for a class of selected sequences.
Publications:	H.M. Fredricksen, "Finding Logarithms for a Class of Shift Register Sequences", submitted to the Quarterly Journal of Research of the National Security Agency.

Title:	NAVSTAR GPS Program Phase III Acquisition Plan, R & D Management and Production Procurement Options Support
Investigator:	William H. Cullin, Adjunct Professor, Department of Administrative Sciences
Sponsor:	NAVELEX
Objective:	To provide analysis and evaluation of management options for 0-III milestone decision documentation/plans/acquisition strategies.
Summary:	Management Planning documentation, i.e. Acquisition Strategy, Source Selection Plan, Acquisition Plan, SOW, have been reviewed, evaluated and input provided. Attendance at weekly meetings of the GPS Phase III Planning Group have been the forum for inputs to the management of the GPS in support of the U. S. Navy Deputy Program Manager of the Joint program office at the Space Division, Los Angeles Airforce Station, Los Angeles, California.
Theses Directed:	E. W. Landgrover and D. L. Rausch, "Survey of Repair Level Analysis Models and Their Application to Navy NAVSTAR Global Positioning System User Equipment", Master's Thesis, June 1983. S. J. Elliott, "An Acquisition Strategy for the NAVSTAR Global Positioning System User Equipment", Master's Thesis, March 1983. T. F. Darcy and G. P. Smith, "Cost Analysis of Navy Acquisition Alternatives for the NAVSTAR Global Positioning System", Master's Thesis, December 1982. W. Scull and R. Nanney, "Analysis of the NAVSTAR-GPS AVSTALL Use Equipment Installation Cost Model", Master's Thesis, December 1983.

Title:	A Mathematical Programming Model Management System Based upon Artificial Intelligence Techniques
Investigator:	Daniel R. Dolk, Assistant Professor of MIS
Sponsor:	NPS Foundation Research Program
Objective:	To study the applicability of artificial intelligence (AI) techniques, especially knowledge representation, to the design and development of generalized software systems that solve mathematical programming models.
Summary:	A survey of knowledge representation techniques was conducted to determine the relative strengths and applicability of various representations for modeling purposes. A hybrid of the techniques in the form of a model abstraction was developed for use with math programming models. The model abstraction most resembles the AI frame concept in structure and function. A prototype model management system (GXMP) based on the model abstraction was implemented for linear programming models. The GXMP system has been tested successfully with several LP problems and shows promise as a generalized modeling system. Several features need to be added including inference and knowledge manipulation capabilities and other MP models (e.g: nonlinear optimization) to demonstrate its generality. Efforts have begun to develop this new version.
Publications:	D. R. Dolk and B. Konsynski; "Knowledge Representation for Model Management systems"; submitted to IEEE Transactions on Software Engineering, July 1983. D. R. Dolk; "A Knowledge-Based Model Management System for Mathematical Programming"; submitted to ACM Transactions on Mathematical Software, September 1983. D. R. Dolk; "A Knowledge-Based System for LP Modeling"; NPS Technical Report, NPS-54-83-012, September 1983.
Conference Presentation:	D. R. Dolk; "A Knowledge-Based System for LP Modeling"; ORSA/TIMS 1982 Joint National Meeting in San Diego.
Theses Directed:	G. W. Watson, Jr.; "Knowledge Base Management for Model Management Systems"; Master's Thesis; June 1983. John J. Troy; "Model Statement Language/Analyzer"; Master's Thesis; June 1983.

Title:	Development and Validation of An Enlistment Suitability Index for the Navy and Marine Corps
Investigator:	Mark J. Eitelberg, Adjunct Professor; Richard S. Elster, Professor and Chair, Department of Administrative Sciences
Sponsor:	Navy Personnel Research and Development Center
Objective:	Statistical analyses were previously conducted to validate aptitude and other entry level information as predictors of attrition for enlisted personnel in each of the military services. The purpose of this project is to extend the exploratory analyses on attrition and to determine the feasibility of incorporating predictor data in an "Enlistment Suitability Index" (or ESI). The efficiency of the ESI will then be determined and compared with other procedures that are used for initial selection of personnel in the Navy and Marine Corps.
Summary:	Navy and Marine Corps data for enlisted personnel in DMDC files have been analyzed to determine the relationships between preservice entry information and subsequent military performance and behavioral criteria. Educational level, age, AFQT scores, and other entry factors have been found to be valid predictors of performance. Composite scores have been derived for these predictors, taking into account the numerous interactions. Cross-validation studies are being conducted to determine the stability of the ESI and to compare its validity with other predictive composites used by the Navy.
Publications:	This project will result in an NPS technical report.

Title: Enlistment Standards and Youth Participation in the All Volunteer Force (Projects I and II)

Investigators: M. J. Eitelberg, Adjunct Professor; P. Hoffman, Adjunct Professor, Department of Administrative Sciences

Sponsor: U. S. Military Enlistment Processing Command

Objective: To perform six integrated research tasks in the subject areas of enlistment standards and youth participation in the All Volunteer Force. The tasks include the following: 1) Policy Analysis of Educational Credentials Used to Determine Enlistment Eligibility; 2) Comparative Analysis of Selection/Assignment Systems for New Recruits in the All Volunteer Force; 3) The Status of Youth Participation in the All Volunteer Force; 4) The Interrelatedness of Civilian and Military Occupations; 5) Hispanics and the Military; and 6) The Participation and Representation of Blacks in the American Armed Forces: Currents through History.

Summary: This project is funded in two parts. Part II is scheduled to commence at the start of FY 1984. It will expand upon analyses undertaken in Task 1 (Educational Credentials) and Task 3 (Youth Participation), with emphasis on aptitude and education standards used for both selection and classification of enlisted personnel.

During the current reporting period, the following was accomplished on Part I:

* A data base was constructed for analyzing educational credentials, as used in the enlistment selection process. The data base covers all services, but focuses on the Marine Corps. A preliminary report was prepared summarizing initial results of the analysis and implications for policy.
* Manuscripts describing the results of Task 2 (Selection/Assignment Systems) and Task 3 (Youth Participation) have progressed toward completion.
* Draft chapters of a book on Hispanics and the Military (Task 5) have been completed after an intensive review of the literature and Defense Department data.
* Data on minority participation in the military have been updated through FY 1983; new statistics on "Profile of American Youth" and qualification rates were linked; and a final manuscript was outlined

(Task 6).

The project tasks will continue, with staggered completion dates scheduled through FY 1984.

Publications: Six separate publications are planned, including NPS Technical Reports, Office of the Secretary of Defense Technical Memoranda, and a commercial publication (Hispanics and the Military).

Theses Directed: D. B. Franks, "Evaluation of Marine Corps Educational Credentials," Master's Thesis, December 1983 (forthcoming).

T. U. Johnson, "Reduction and Interpretation of NLS and ASVAB Data," Master's Thesis, December 1983 (forthcoming).

Title:	Research Studies and Analyses to Evaluate and Improve the DOD Personnel Security Program
Investigators:	M. J. Eitelberg, Adjunct Professor; and John Goral, Adjunct Professor, Department of Administrative Sciences
Sponsor:	Directorate for Budget and Finance, Office of the Secretary of Defense
Objective:	This project seeks to develop a DoD Personnel Security Research Program. The first major research project under the new program examines the potential of psychological assessment techniques for personnel security screening. The second phase consists of a number of related studies to evaluate the reliability and validity of both the current adjudicative process and the types of information upon which adjudicative decisions are based. To facilitate research and analysis, this project links automated individual personnel records with individual information in the available personnel security files. This linkage of personnel and screening records permits longitudinal analysis of security clearance actions as well as the cross-sectional studies commonly used to identify trends.
Summary:	The Defense Central Index of Investigations (DCII) data base and other Service files are being processed by DMDC for the Naval Postgraduate School. Analyses are being conducted to determine the characteristics and subsequent failure rates of enlisted personnel receiving top-secret clearances for nuclear-related jobs and intelligence specialties. The validities are being determined for screening procedures currently employed by each Service in assigning individuals to high-risk jobs. Results to date indicate that the personnel security screening process can be improved in several areas.
Publications:	This project will result in an NPS techical report and other publications.
Conference Presentation:	M. J. Eitelberg, "The Development of a DoD Personnel Security Research Program," Naval Postgraduate School, September 1983.

Title:	An Analysis of Methods for Use in the Accrual of Manpower Costs
Investigator:	K. J. Euske, Assistant Professor of Accounting, Department of Administrative Science
Sponsor:	Director, Manpower Planning and Analysis Office of the Assistant Secretary of Defense
Objective:	The objective of this project is to analyze the full cost to the taxpayer of a manpower decision.
Summary:	The analysis includes questions of the proper accrual method and may include questions of allocation, depending on the types of resources affected by the decision.
Publications:	K. J. Euske, D. Smith, and G. W. Thomas, "Accounting for and Reporting Military Retirement Costs to Manpower Decision Makers", submitted to Georgia Journal of Accounting.
Theses Directed:	Donald F. Smith, Jr., "A Sensitivity Analysis of Entry Age Normal Military Retirement Costs," Master's Thesis. September 1983.
	Steven Waterman, "Allocation Methods for Use in the Accrual of Manpower Costs," Master's Thesis. June 1983.

Title: Development of a Back-Channel MCCRES Reporting System

Investigator: K. J. Euske, Assistant Professor of Accounting
Department of Administrative Sciences

Sponsor: Readiness Branch, Headquarters United States Marine Corps

Objective: The objective of this research project is to develop a communication system that provides positive, meaningful information to the unit commander.

Summary: Measuring the readiness of a military unit through the use of MCCRES data base provides a vehcile to supply the unit commander with information that will assist him in using limited resources effectively and efficiently to accomplish the unit's objectives. The information must be tailored such that the unit commander can actively use the input to alleviate actual or perceived relative deficiencies.

Theses Directed: Larkin E. Conatser, "Marine Corps Combat Readiness Evaluation System (MCCRES): Three Case Studies for Use in Providing a More Effective Evaluator," Master's Thesis. December 1983.

Thomas P. Finnerty, "An Analysis of the Feedback From the Marine Corps Combat Readiness Evaluation System," Master's Thesis. December 1983.

George M. Wheeler, "Evaluator Bias in the Marine Corps Combat Readiness Evaluation System (MCCRES): Its Identification and Control," Master's Thesis. June 1983.

Title:	An Investigation of the Federal Government's Information Needs and Uses for Depreciation
Investigator:	James M. Fremgen, Professor of Accounting, Department of Administrative Sciences
Sponsor:	NPS Foundation Research Program
Objective:	To identify actual and potential users of Federal financial reports, to determine the natures of their uses of the information, and to assess the relevance of depreciation to those uses.
Summary:	A survey of the theoretical literature and official pronouncements on governmental accounting was made to identify issues regarding depreciation accounting. These issues were used as the basis for structured interviews with Federal accounting policy makers and accounting data users in both the legislative and executive branches. Current actual practices in the Federal government were determined and compared with those in municipal governmental accounting.
Conference Presentation:	"On the Role of Depreciation in Governmental Accounting". To be presented at the Western Regional Meeting of the American Accounting Association on April 20, 1984.
Publications:	Fremgen, James M., "On the Role of Depreciation in Governmental Accounting", submitted to the Journal of Accountancy.

itle: Analysis of Sole Source vs Dual Source Procurement of Advanced Weapon Systems

nvestigator: Willis R. Greer, Jr., Professor of Accounting, and Shu S. Liao, Associate Professor, Department of Administrative Sciences

ponsor: Office of Naval Research/NAVAIR,NAVMAT

bjective: This study attempts to identify market environments relevant to the sole source vs dual source decision for the procurement of major weapon systems. The pricing behavior of contractors operating in these environments will be analyzed and its impact on program cost will be evaluated.

ummary: Despite the multitude of empirical studies during the past decade, there has been only a modest reduction in the uncertainty in estimating the savings from introducing competition to previously sole-sourced procurements. Past research has concentrated on building a cost production model on the basis of empirically-derived determinants, such as learning curve and production rate. We incorporated market environments in the analysis of contractors' pricing behavior. The aerospace industry's capacity utilization level was used as a measure of business conditions. The result shows that greater savings do appear to have resulted from competition when capacity utilization was relatively low and the Government suffered losses when it introduced competition during the period of high capacity utilization. The cost estimation model that includes the capacity utilization term also outperforms the models currently in use.

ublications: Willis R. Greer, Jr., and Shu S. Liao, "Competitive Weapon Systems Procurement: A Summary and Evaluation of Recent Research," National Contract Management Journal (Winter 1984).

Willis R. Greer, Jr., and Shu S. Liao, "Production Rate vs. Capacity Utilization as Cost Estimation Improvement Variables under Competition," under review for publication in Naval Research Review.

Willis R. Greer, Jr., and Shu S. Liao,"Cost Analysis for Competitive Major Weapon Systems Procurement," NPS Technical Report, NPS54-83-011, October 1983.

Conference Presentation: Willis R. Greer, Jr. and Shu S. Liao, "Contractor 'Hungriness' and the Relative Profitability of DoD Business," Proceedings of 1983 Federal Acquisition Research Symposium.

Thesis Directed: David F. Britt, "An Analysis of the Profitability of Major Defense Aerospace Contractors," Master's Thesis, September 1983.

tle: Human Resource Management System: Research and Support Project

vestigator: Reuben T. Harris, Associate Professor of Management and Carson K. Eoyang, Associate Professor of Management, Department of Administrative Sciences

Associate Investigators:

Richard McGonigal, Associate Professor of Management
CDR Richard Bishop, Instructor in Management,
Department of Administrative Sciences

onsor: Chief of Naval Operations (OP-15)
Naval Military Personnel Command (NMPC-6)

jective: To provide continuing research, analysis, training and consultation support to the U.S. Navy's Human Resource Management Support System (HRMSS) at both field and staff levels.

mmary: Since FY 79, numerous activities were conducted under this project in support of the above objective. Two long-term demonstration projects were undertaken with the goal of improving the capability of HRMC's and documenting the strategy and outcomes of those efforts. The two project sites are HRMC San Diego and HRMC Pearl Harbor. Also NPS faculty have delivered training activities at HRMC's and HRMD's at Pearl Harbor, San Diego, Alameda, Norfolk, Charleston, Washington, D.C., and NPS. NPS faculty planned and managed the Military HRM Symposium held at NPS (November 1978). Finally, NPS faculty designed and delivered annually since 1979 a two-week Advanced OD Course for HRMC OD Specialists.

Regarding activities of the past year, the major thrust has been in three areas. First, several research projects (including theses) have been undertaken to provide the sponsor with knowledge and guidance in several important policy-making arenas. Secondly, significant resources were employed in delivering advanced conceptual and skill training in OD to consultants in the Navy's HRMSS. These included a two-week course (60 participants) at NPS and on-site training in WestPac, Europe and throughout CONUS. Finally, NPS faculty have provided the sponsor with direct consultations regarding OP-15/NMPC-6 efforts directed at reorganization of the Navy's HRMSS. These

efforts have resulted in a major restructuring of the entire HRM Program which has been approved by OP-01, VCNO and CNO.

In addition various consulting assistance has been provided to the Surgeon General, Office of the Undersecretary of the Navy, the Deputy Inspector General of the Navy, and other senior officials.

Publications: C.K. Eoyang and R.T. Harris, Assessment of Advanced HRM Training Program, Monterey, CA November 28-December 10, 1983.

Thesis Directed: L. E. Wargo, "Developing Competencies for Navy HRM Specialists", Master's Thesis, June 1983.

tle: A Tool for Rapid Generation of Regression Functions for Ad Hoc Groupings

ıvestigator: P. J. Hoffman

ıonsor: Navy Personnel Research and Development Center

ıjectives: To develop prediction functions for current Marine Corps Enlisted personnel, with the ultimate goal of optimizing the assignment algorithm for training assignments.

To formulate a research strategy for development of a decision-aid, by means of which assignment algorithms can be quickly altered to revised manpower requirements.

ımmary: The prediction functions have been generated for each of 54 training assignments, and accuracy of predictions have been estimated from the data. Work on the decision-aid has been deferred due to unavailability of research funds.

Development of a Model for Effective Cross-Cultural Interactions Within Organizations

igator: Solange Perret, Assistant Professor of Accounting

r: NPS Foundation Research Program

ive: To study the impact of cultural differences on management practices in multinational organizations, and to initiate the development of a framework for designing management systems adapted to multicultural environments.

y: The study was conducted in four locations (England, France, Holland, and the USA) of a large multinational accounting firm. The study showed that the definition of quality for the services provided varied substantially between the four countries. (Quality was defined as what the partners felt quality meant in their work and as what the client firms required from their accounting firm.) Furthermore, the differences in the definition quality were strongly related to specific cultural differences as measured with the Kluckhohn and Strodtbeck instrument. Conclusions were that this instrument is valid to identify some major differences between cultures and can be used to design management systems adapted to specific cultural environments.

Title:	Development of a Framework for Management Control and Assessment of the State of the Art in Business Firms
Investigator:	Solange Perret, Assistant Professor of Accounting
Sponsor:	NPS Foundation Research Program
Objective:	To examine the current budgeting practices of the Fortune first and second 500 largest U.S. firms, and to assess the validity of a contigency model which states that in order to be successful, firms need to adapt their environment (simple versus static, and stable versus dynamic)
Summary:	Firms in four industries were surveyed (Apparel, Aerospace, Chemical and Wood), each of these industries representing a different type of environment. There was a characteristic profile of budgeting practices in each industry, and the four profiles were significantly different. Furthermore, the nature of the differences was consistent with hypotheses formulated from the contingency model.
Publications:	In Progress: "Environmental Uncertainty and Budgeting Practices: A Comparison of Budgeting Practices in Four Industries".
Thesis Directed:	Lt. Michael O. Roesner, "An Analysis of Budgeting in Four Industries", December, 1983.

e:	High School Graduate Information System
stigator:	Nancy A. Nieboer, Adjunct Research Professor of Psychology
sor:	Office of the Assistant Secretary of Defense (MRA&L) Directorate of Accession Policy
ctive:	To develop an accurate and detailed information system covering public, private, and parochial secondary schools, which is needed to improve defence high school testing and recruiting programs.
ary:	Data tapes have been acquired from the various commercial and Defense sources previously identified for this ongoing project. Most of the major files have been integrated, and a sample listing of selected schools revealed no formatting difficulties. The data file layout originally developed for the High School Information System was modified to accommadate user interests and expressed needs.
entations:	Nancy A. Nieboer, "Progress in the Development of a High School Graduate Information System," Joint Service Selection and Classification Working Group, San Antonio, Texas, 21 April 1983 and Washington, DC, 23 August 1983.

Title:	Evaluation of Efforts to Supplement the DOD High School Testing Program with Commercial Standardized Tests
Investigator:	Nancy A. Nieboer, Adjunct Research Professor of Phychology
Sponsor:	Office of the Assistant Secretary of Defense(MRA&L) Director of Accession Policy.
Objective:	To provide a thorough and detailed evaluation of the supplemental high school testing program, with recommendations for future application, to improve Defense high school testing programs.
Summary:	Defense-subsidized commercial testing was conducted in the Midwest, West, and New England during 1982-83. Information about the program was obtained from the testing agencies, school officials, students, and the Services. Public perceptions of the program were favorable, students expressed interest in learning about Defense training and education programs, and Service recruiters found the detailed information provided by the leads helpful. Final reports from the Services for this ongoing project were delayed until first quarter 1984.
Presentations:	Nancy A. Nieboer, "Evaluation of Commercial Standardized Testing," Joint Service Selection and Classification Working Group, San Antonio, TX, 21 April 1983 and Washington, DC, 23 August 1983.

itle:	Evaluation of Modified Commercial Standardized Testing Program as a Supplement to Defense High School Testing
ıvestigator:	Nancy A. Niebor, Adjunct Research Professor of Psychology
ɔonsors:	U. S. Army Recruiting Command U. S. Air Force Recruiting Service U. S. Marine Corps
ɔjective:	To provide a thorough evaluation of the modified supplement high school testing program, with recommendations for future improvements in Defense high school testing programs.
ɹmarry:	Arrangements for testing were near completion and availability of many of the data were assured. This project began in September 1983, and continues throughout FY1984.
resentations:	Nancy A. Nieboer, "Modified Commercial Standardized Testing Pilot Project," Joint Services Selection and Classification Working Group, Washington, DC, 23 August 1983.

Title: Stock Coordination Management between NAVELEX and SPCC.

Investigator: Alan W. McMasters, Associate Professor of Operations Research and Administrative Sciences

Sponsor: Naval Electronic Systems Command

Objective: This is a continuing research effort addressing the question of when inventory management of an item should be transferred from NAVELEX to SPCC.

Summary: The failure rate computations and the format of the printouts being sent to NAVELEX for use in stock coordination were refined.

Analysis of failure rate data lead to the conclusion that high failure rates during the first year of two of use of an electronic item by the fleet may not imply design instability. These rates may be the result of demands by the fleet to replace an outdated item. Replenishment buys for electronic items were also found to usually result in a "new" item because of NAVELEX's desire for state-of-the art equipment or because of the difficulty in providing detailed, technical packages to contractors. As a consequence, a buy of an electronic repairable will be considered a "life of type" buy. The impact on stock coordination is that if a repairable item is transferred to the inventory control of SPCC, it will probably never be reprocured and will be managed only for repair and cannibalization of parts.

Hund, John J., "A Two-Period Repair Pact Inventory Model for a Naval Air Rework Facility", Master's Thesis, December 1982.

Orr, W. David, "Estimation of the Local Delivery Costs at Naval Supply Center, San Diego, California", Master's Thesis, June 1983.

Title: Development of a Local Area Material Distribution Plan

Investigator: Alan W. McMasters, Associate Professor of Operations Research and Administrative Sciences
Larry Bodin, Adjunct Professor of Operations Research

Sponsor: Naval Supply Systems Command

Objective: This is a continuing research effort to develop a general material distribution plan for local area support by a large wholesale activity which can then be applied to the Naval Supply Centers at Oakland, San Diego, and Norfolk.

Summary: The documentation of the local delivery systems at NSC's Oakland and San Diego were completed. In addition, the costs of the system at San Diego were determined. With this detailed information in mind, the need for a vehicle scheduling algorithm was evaluated both for off-base and on-base movements. The conclusion was that computerized vehicle scheduling algorithms did not appear to be needed.

The second area of investigation extended the preliminary NARF Ready Supply Stores single item inventory model from a planning horizon of only one quarter to two quarters and then to any number. The two-period model was algebraically very complex and the benefits of using the single period model instead were evaluated. Later, the complexity of the two-period model was overcome through the use of a multi-period dynamic programming functional form. This form was easy to program. Solutions for examples with an eight quarters horizon were then computed in less than a second of CPU time.

Publications: McMasters, Alan W. and Bodin, Larry, "Vehicle scheduling algorithms for Naval Supply Center local delivery systems", draft memorandum dtd 28 July 1983, submitted to the sponsor.

Theses Directed: Asselin, Andre S., "A Multi-Period Repair Parts Inventory Model for a Naval Air Rework Facility", Master's Thesis, September 1983.

Flohr, Larry E., "An Analysis of NSC San Diego's Broadway Compound and National City Annex Local Delivery System", Master's Thesis, December 1982.

Title: An Assessment of Personnel Attributes and Ships' Readiness Relationships

Investigator: William E. McGarvey, Adjunct Research Professor of Psychology, Department of Administrative Sciences

Sponsor: Office of Naval Research/OPNAV914

Objective: To examine the relationships between personnel attributes and measures of material readiness, viz., Casualty Reporting (CASREP) data, in order to test the general proposition that "more is better". I.e., ships with higher fill-ratios (number of billets filled versus number of billets authorized), more experienced, more intelligent crews out to report systematically fewer difficulties. Three ship classes (SPRUANCE, ADAMS, & LEAHY/BELKNAP), twelve critical ratings, and their putative CASREP performance across twenty-seven quarters were analyzed.

Summary: Although several analytic variants were tested, the picture that emerges is immensely complicated and only infrequently invariant over ratings, attributes, and ships. Much of the variance in the rate of CASREP production is attributable to ship differences, and not to personnel aboard the vessels.

Publications: LCDR John May, "An Analysis of the Relationships of Personnel Characteristics to the Performance of DD963 Class Ships", Naval Postgraduate School thesis, December 1983.

LCDR John May, William E. McGarvey, and Richard S. Elster, "Relating Resources to Readiness: Personnel Attributes, Fill Ratios, and CASREPSs," in progress.

LCDR Jeff Crane, "Deployment Cycles, Grade Fill, Personnel Attributes, and CASREPs", Naval Postgraduate School thesis, in progress.

Title:	Development of a Prototype On-Line Automated Defective Material Reporting System
Investigator:	Norman R. Lyons, Associate Professor of Information Systems
Sponsor:	Fleet Material Support Office
Objective:	To design a prototype system for an automated office for the reporting of quality deficient items at FMSO.
Summary:	A prototype system was designed using IBM PC's, Orchid Technology's PC-Net and Ashtontate's dBase II. In the course of the project, the size requirements for the system changed by a factor of four. The command then decided to implement the system on a mainframe using FOCUS. The systems analysis and database design for the smaller project were able to be moved to the larger system.
Thesis Directed:	Carriger, Michael, "A Systems Analysis and Design for Updating the Internal Tracking of the Quality Deficiency Reporting System at the Navy's Fleet Material Support Office", Master's Thesis, June 1983. Boynton, John and Nichols, Ron, "The Implementation of a Central Database on a Network of Microcomputers", Master's Thesis, March 1984.

Title:	Analysis Capability in Support of the National Communications System
Investigator:	Jack LaPatra, Adjunct Professor, Department of Administrative Sciences
Sponsor:	National Communications System
Objective:	a) to determine NCS operating requirements b) to install the WAAM Model on the NPS Vax computer c) to establish a library of reports and data bases. d) to survey pertinent methodologies in the analytical field e) to improve useful analytic methodologies
Summary:	Progress was made on each of the above objectives and a report summarizing the progress was submitted. Funding ($200,000) has been received for continuing the work during FY 1983/84.

B. Technical Reports

1. Neches, T.M., "A Critical Review of Level of Repair Models", The Assessment Group, Technical Report D-206, April 1983.

C. Theses

1. Nielsen, V.D. and H. Shahal, "Application of Life Support Cost, Provisioning, and Repair/Discard Models to Weapon System Procurement Decisions by Small Countries", Master's Thesis, Naval Postgraduate School, December 1983.

2. Watras, H.J., "Combining a Level of Repair Model with an Availability Centered Provisioning Model for Logistic Support Analysis", Master's Thesis, Naval Postgraduate School, September 1983.

3. Menyhert, C.F., "An Evaluation of the United States Army SESAME and Swedish OPUS VII Provisioning Models", Master's Thesis, Naval Postgraduate School, December 1983.

4. Dostal, P.S. and J. M. McNeal, "An Analysis of the Marine Corps Level of Repair Model (MCLOR) and the Navy Availability Centered Inventory Model (ACIM) from an Operational Availability Standpoint", Thesis, Naval Postgraduate School, December 1983.

Title: Comparison of DOD Weapon System Level of Repair Models

Investigator: M. B. Kline, Professor, Department of Administrative Sciences

Sponsor: Office of Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics)

Objective: To perform comparative studies and analyses of selected level of repair models with regard to input requirements, computational aspects, measures of cost effectiveness used, and output information using repair levels and system structures as a test basis.

Summary: Several level of repair and provisioning models were selected for evaluation from a candidate list of existing models. These were installed on the NPS computer. It was found that existing LOR models, while useful for making decisions as to which maintenance echelons and to which system indenture level are cost effective for performing maintenance actions, do not contain efficient of effective provisioning algorithms and are not in accordance with the DoD standard definition of operational availability. Therefore, the LOR models investigated were linked to provisioning models to determine what operational availability was obtained with the LOR provisioning allocation.

It was found that when the provisioning models were used to make the allocations, substantially higher operational availabilities could be achieved for the same cost, or lower cost for the same availability. The research results also showed that LOR models could be linked to provisioning models and that such a linkage could produce optimal results for both maintenance and supply.

Publications: A. Papers

1. Kline, M. B., " A Survey of Logistics Analysis Models", Proceedings, 17th Annual International Logistics Symposium, Society of Logistics Engineers, Aug 1982

2. Kline, M. B., "Linking Level of Repair Analysis Models to Provisioning Models", Proceedings, Second Quality Assurance Symposium, Israel Society for Quality Assurance, October 1984

Title:	Training-Systems Cost-Effectiveness Study
Investigator:	Fenn C. Horton, Associate Professor, Department of Administrative Sciences
Sponsor:	NAVAIR
Objective:	Long term: Evaluation of cost-effectiveness of conventional training techniques relative to that of computer-involved techniques. Short term: a review of the pertinent literature and a series of interviews with scholars who have been in the vanguard of experimentation and evaluation in the field of computerized training.
Summary:	The literature search and the interviews revealed no investigators in America or Europe who have conducted rigorous tests involving computer-based and other training techniques designed to identify that technique which delivered a required level of training effectiveness at minimum cost. In the course of his interviews, this investigator discovered an imminent opportunity to perform such tests and he informally proposed such tests to the sponsor.

Title: The Impact of Organizational Constraints on the Design and Implementation of Management Information Systems

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

Sponsor: NPS Foundation Research Program

Objective: The objective of this research project was to examine the impact that organizational constraints such as stated goals and objectives, organizational structure, critical factors concerning the nature or economics of operations, and others have on the design and implementation of management information systems. Field work was carried out to test several research hypotheses.

Summary: All large, complex organizations, profit oriented as well as those that are nonprofit oriented, have decentralized or hierarchical responsibility for the management of resources that are available to the organization. Resources typically consist of humans (managers and workers), physical items (inventories, equipment, building), and financial (cash and other funds) means. A rigorous analysis of each organization helps identify certain characteristics that are invariant over a relatively long time frame (e.g., three to five years). These characteristics can be viewed as constraints or givens because changes are relatively infrequent. Also, changes require major policy decisions of top managers and the board of directors or some other governing body. The organizational constraints identified in this research as having significant influence on the design of management information systems were: organizational structure; organizational goals and objectives; and the nature or economics of major operating activities or businesses.

The results of the research demonstrate that the design of an effective management information system for a particular organization depends on a careful assessment of its organizational constraints. Organizational structure formally defines how an organization divides its resources among managers who are held responsible for their efficient and effective utilization. Goals and objectives provide guidelines to help motivate each manager to do a good job. An understanding of the

nature or economics of the operations helps identify key variables that determine whether or not the organization will succeed or fail in reaching its goals and objectives.

Field research within one organization engaged in service operations helped confirm the importance of the organizational constraints in the design of information systems to help managers achieve satisfactory performance. Three criteria for success were: minimizing service time, meeting planned completion date, and cost effectiveness. In this particular setting the organization, which is a subdivision of a larger organization, was held responsible for meeting certain profit goals that were beyond its control. However, in practice, management was only marginally concerned with this imposed objective. Instead their decision making was primarily concerned with the above three success factors. This research raised a serious question as to imposed profit objective in light of the lack of influence that exists over the price that is charged for service.

Publications:

J. G. San Miguel, "A Constraint Based Framework for Management Planning and Control Systems," in progress.

J. G. San Miguel, "The Effectiveness of Management Control in Service Organizations: A Field Study," in progress.

Thesis Directed:

Anne Long, "Cash Management in the Naval Industrial Fund," Master's Thesis, in progress.

Title:	Computer Network Design
Investigator:	Norman F. Schneidewind, Professor of Computer Science, Administrative Science and Computer Science Departments
Sponsor:	Fleet Material Support Office and Naval Supply Systems Command
Objective:	To develop models, concepts and design methodologies in the areas of computer networks and distributed systems as applied to the design of the Stock Point Logistics Integrated Communications Environment.
Summary:	During the past fiscal year the following was accomplished and provided to the sponsor: 1) methodology for the design of distributed systems. 2) design of a distributed operating system for local networks. 3) concept of a dictionary directory system.
Publications:	Norman Schneidewind, "Interconnecting Local Networks to Long-Distance Networks", Computer, Vol. 16, No. 9, IEEE Computer Society Press, September 1983, pp. 15-24. Norman Schneidewind, "Functional Approach to the Design of a Local Network: A Naval Logistics System Example", Digest of Papers Spring Compcon 83. Twenty-Sixth IEEE Computer Society International Conference, IEEE Computer Society Press, March 1983, pp. 197-202. Norman Schneidewind, "Functional Design of a Local Area Network for the Stock Point Logistics Integrated Communications Environment", NPS Technical Report, NPS-54-82-003, December 1982.
Conference Presentation:	Norman F. Schneidewind, "Functional Approach to the Design of a Local Network: A Naval Logistics Example," Twenty-Sixth IEEE Computer Society International Conference, San Francisco, February 28 - March 3, 1983.
Theses Directed:	Cosmos Charpantidis, "Development of a Simulation Model for a Local Area Network", Master's Thesis, June 1983. E. Jean Dixon, "Application of Data Base Machines to SPLICE," Master's Thesis, June 1983.

Dan P. Krebill and David D. Carlsen, "The Design and Specification of a Communications Interface Between a Local Area Network and the Defense Data Network," Master's Thesis, June 1983.

Sharron K. Crowder and Jan M. Adams, "Proposal for Stock Point Logistics Integrated Communications Environment (SPLICE) Local Area Network Risk Management," Master's Thesis, December 1982.

Kathlean M. Barrett, "Integration Considerations for the Stock Point Logistics Interated Communications Environment (SPLICE) Local Area Network", Master's Thesis, December 1982.

Craig E. Opel, "Network Management of the SPLICE Computer Network", Master's Thesis, December 1982.

Samuel E. James, "Technical and Economic Analysis of Planned Visual Display Terminal Employment for the Stock Point Logistics Integrated Communications Environment (SPLICE)", Master's Thesis, June 1983.

Jerry D. Barnes, "Local Area Network Terminal Management in Support of Stock Point Logistics Integrated Communications Environment (SPLICE)", Master's Thesis, December 1982.

Petros Magoulas, "Hardware and Software Implementation of a Proposed Local Area Network Design", Master's Thesis, March 1983.

Seong Sig Bae and Koo Don Chung, "A Simulation Model for a Local Area Network (LAN) Design in Support of Stock Point Logistics Integrated Communications Environment (SPLICE)", Master's Thesis, March 1984.

Title:	A Distributed Operating System Design for the SPLICE
Investigators:	Norman F. Schneidewind, Professor of MIS (Principal Investigator) Daniel R. Dolk, Assistant Professor of MIS
Sponsor:	Fleet Material Support Office
Objective:	To suggest a design for a distributed operating system for the ongoing project known as the Stock Point Logistics Integrated Communications Environment (SPLICE). As part of this design, to consider the role of a dictionary/directory system (DDS) for managing information resources within SPLICE.
Summary:	Prof. Schneidewind worked on the overall distributed operating system and Prof. Dolk on the DDS. The role, function, structure and usage of DDS within a distributed computing system were considered as well as the special problems resulting from that environment. Preliminary logical schemas for a distributed DDS were proposed as well. The study of the DDS was a survey whose purpose was to highlight issues for further research. Among these issues are how to distinguish between local and global components of a DDS and how to distribute them within the SPLICE network.
Publications:	N. F. Schneidewind and D. R. Dolk; "A Distributed Operating System Design and Dictionary/Directory for the Stock Point Logistics Integrated Communications Environment"; NPS Technical Report, NPS-54-83-014, November 1983 (written September 1983).

Title: Research and Development Program in Fundamental Cognitive Skills Assessment, Development and Utilization in the Navy.

Investigator: Thomas G. Sticht, Adjunct Research Professor of Industrial Psychology, Department of Administrative Sciences.

Objective: To participate in research on fundamental cognitive skills of Navy personnel

Summary: Major activity during the project period involved the adaptation of a computer program for teaching reading to permit its use with the IBM PC. Additionally, the investigator participated in the planning of research at the Navy Personnel Research and Development Center on general problem solving, bilingualism, and functional context training. A tri-service conference on cognitive science was conducted at the Naval Postgraduate School.

Publication: Proceedings of the Tri-Service Conference on Cognitive Science Applications to MPT Problems (Sticht and Chang, Eds.) in progress.

Conference Presentation: Presentations at the American Educational Research Association, 1983; International Reading Association, 1983; Roundtable on Adult Illiteracy, Washington, D. C. 1983; National Adult Literacy Project, Washington, D. C. 1983.

Title:	Preliminary Modeling of Force Competency and Interactive Program to Analyze Compensation Changes Under the Force Competency Concept
Investigator:	Thomas G. Swenson, Assistant Professor, Department of Administrative Science
Sponsor:	HQ U. S. Army Soldiers Support Center
Objective:	(1) To develop a conceptual model of the interaction of the Force Competency based compensation system on force structure. (2) To develop an interactive computer program capable of performing preliminary on the five MOS's used in the pilot program to test the Force Competency concept of compensation.
Summary:	During the past fiscal year the following was accomplished and provided to the sponsor: (1) Conceptual model of the effect of compensation of force structure. (2) Interactive computer program.
Publications:	Robert A. Butler and Oliver L. Frankel, "Performance Based Management System Economic Analysis Model", The Assessment Group, B-100 December 1983 Robert A. Butler and Oliver L. Frankel, "Perfomance Based Compensation Analysis Model", The Assessment Group, R-217, January 1984.
Thesis Directed:	George Yacus, "Application of a Performance Based Compensation Analysis Model to the United States Navy", Master's Thesis, June 1984.

Title: Theoretical Understanding of Recruiting Source Consequences

Investigator: Thomas G. Swenson, Assistant Professor, Department of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To develop a framework for the theoretical understanding of recruiting source characteristics and organizational consequences.

Summary: To date:

1. Review of relevant literature to the private sector has been completed and a review of recruiting literature DoD-wide is in progress.
2. Theoretical framework for understanding the organizational consequences of recruiting source consequences has been completed.
3. Private sector data base has been collected and extensive analysis is nearing completion. Also U.S. Coast Guard data base has been developed in conjunction with thesis by Harvey Johnson.
4. Work has recently been completed on a conceptual paper, co-authored with CDR Mairs, on the strategic evaluation of recruiting sources.
5. Conceptual paper dealing with the strategic evaluation of recruiting sources is being extended with the assistance of Bob Butler of the Assessment Group into a paper which develops a mathematical model of recruiting source effectiveness that evaluates recruiting sources from the perspective of return on investment.

Title:	Development of a Retention Utility Index
Investigator:	George W. Thomas, Associate Professor of Economics
Sponsor:	Naval Personnel Research and Development Center
Objectives:	To develop a systematized procedure for determining which Navy occupations have the largest utility from retaining trained and experienced personnel.
Summary:	A multiattribute utility function was developed as a Retention Severity Index (RSI). Five personnel components were used in the RSI model; (1) size, (2) shortage, (3) growth, (4) cost, and (5) priority. The Retention Severity Index was applied to 85 Navy ratings in each of three reenlistment zones.
Publications:	G. Thomas and M. Driggers, "Application of Multiattribute Utility Theory to Assess the Retention Severity of U.S. Navy Occupations," draft for submission to Decision Sciences.
Conference Presentation:	G. W. Thomas and M. Driggers, "Development of a Retention Severity Index for U.S. Navy Occupations" submitted for presentation American Institute for Decision Sciences, Western Meetings.
Thesis Directed:	M. Driggers, "Retention Severity in the Navy: A Composite Index," M.S. in Management, June 1983.

itle: Costs and Benefits of Older Age Personnel

ıvestigator: George W. Thomas, Associate Professor of Economics

ɔonsor: Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics)

ɔjectives: To analyze the relationships of military enlistee entry age welts: job satisfaction, quality of personnel, career intentions, and personnel costs.

ɯmmary: The size of the typical entry age pool (17-20 years old) is decreasing during the 1980's. Analysis indicated differences exist between entry age cohorts as to service selection, marital status, education, AFQT performance, attrition, promotion and reenlistment intent, perceptions of civilian employment, and attitudes towards military life. The older age cohort (21-25 years old) is a viable source of supply for manpower requirements in the 1980's and beyond.

ıeses Directed: S. M. Kruetner, "Social Economics and Behavioral Differences Among Enlisted Personnel Based on Age at Service Entry," M.S. in Management, October 1982.

R. W. Stanley, "Empirical Analysis of the Decision to Enter Military Service Based on Age at Service Entry," M.S. in Operations Research, June 1983.

Title:	Support of the Defense Productivity Program Office (DPPO) and Projects (1982-1983)
Investigator:	David Whipple, Professor of Economics and Policy Analysis, Associate Chair for Operations, Department of Administrative Sciences
Sponsor:	OASD (MRA&L), Civilian Personnel Policy
Objective:	To assist in the restructuring of DPPO's programs and internal organizations in accordance with the recommendations derived in the 1982 portion of our effort, and to begin a continuing program of research in productivity enhancement to support DPPO and CPP needs.
Summary:	Utilizing an analytical model developed during our 1981 Naval Postgraduate School Foundation research on intra-organizational behavior, we assessed the internal consistency and goal congruence of the activities and programmatic structure of DPPO with both the stated purpose for its establishment (as contained in DoD Directive 5010.3) and the needs of other interested individuals and organizations dependent in various ways on the productivity-enhancing efforts of DPPO. The conclusions and recommendations were briefed to Mr. Jerry Calhoun, the Deputy Assistant Secretary for CPP, who accepted them and asked us to continue both our consultive and research support. We have agreed on expecting the relationship to extend into the foreseeable future. A number of scholarly publications are planned, the initial being an analysis of the inadequacies of present DoD productivity measures.
Publications:	David Whipple et al., An Evaluation of the Defense Productivity Program Office Activities and Organization, Final Report, April 1983, 95 pages.
Conference Presentation:	David Whipple and James Tweeddale, "Policy Issues in the Development of the Defense Industrial Base: The Role of Productivity Enhancement", Association for Public Policy Analysis and Management Annual Meeting, Philadelphia, September 1983.

DEPARTMENT

OF

OPERATIONS RESEARCH

DEPARTMENT OF OPERATIONS RESEARCH

Operations Research (OR) is a multi-disciplinary field, a fact which s reflected in the variety of areas covered by the sponsored research of he faculty. The applications areas include combat models, manpower and ersonnel, supply and logistics, tactical analysis, and command, control, nd communication.

ATHEMATICAL PROGRAMMING

Professors Brown (ONR) of Operations Research, Bradley (ONR) of omputer Science and Wood (NSF) of Operations Research continue their esearch programs in the theory and application of large scale optimiza- ion. They have developed new approaches for solution of large scale etwork reliability models. As a result of this research program, the aval Postgraduate School continues to have one of the most powerful kisting optimization laboratories. The National Research Council of ne National Academy of Sciences has recognized the fundamental contribu- ions of this effort and supports a resident Postdoctoral Fellowship rogram in optimization with Professor Brown.

TOCHASTIC MODELING/STATISTICS

Professor Gaver, under ONR funding, continues development of stochastic odels and statistical data analysis methodology for communications systems, omputer systems, systems involving maintenance and repair, and environmental rediction. The latter work, in collaboration with Professor Jacobs, is artially sponsored by NEPRF.

Professors Jacobs and Lewis continue to derive properties for new tochastic point processes and time series models.. In addition, new methods or simulating a broad class of stochastic point processes have been dis- overed. Applications of these processes to oceanographic phenomena are eing pursued. This work is supported by ONR and the National Science oundation. Professor Lewis also continues work in simulation analysis, articularly development of a revision to the LLRANDOM generator.

Professor Esary has continued his studies in reliability. Professor arson and Professor Jayachandran of Mathematics have continued analysis of pectrometric data from oil analysis under sponsorship of the DOD. Professors ead and Tysver have continued work on torpedo tracking programs for the aval Undersea Warfare Engineering Station.

OMBAT MODELS

Professors Parry and Hartman continue to develop a computer simulation odel of air/land combat for the U. S. Army Training and Doctrine Command. his model is now being used for studies supporting current decisions. rofessor Taylor has continued his studies of warfare via Lanchester-type ifferential equations. This work was supported by ONR and the Army

Office. A text on Lanchester Models of Warfare was published in
rofessor Taylor is now focusing in Soviet cybernetics and troop/
ntrol. This work is supported by ONR.

ANALYSIS

e tactical analysis division of ONR continued to fund a long-term
led by Professor Washburn.. Professors Forrest and Shudde continued
rk in hand-held computer evaluation. Professor Eagle began a
whose goal is discovery of efficient anti-submarine search tactics.
rs Washburn and Shubert continued the 1982 work on minefield planning,
hasis on simple, protable tools for planning uncountered minefields.
y of tactical theses were also guided and supported by this contract.

ofessor Andrus, under a separate contract, continued his evaluation
actor support for the tactical analysis program. Professor Forrest
d to direct the Strategic Systems Project Office research program.

AND PERSONNEL

ofessor Milch has initiated the Army Manpower/Personnel Research
involving faculty and Army students to work on specific Army
models under Army MILPERCEN sponsorship.

PUT TO COMPUTERS

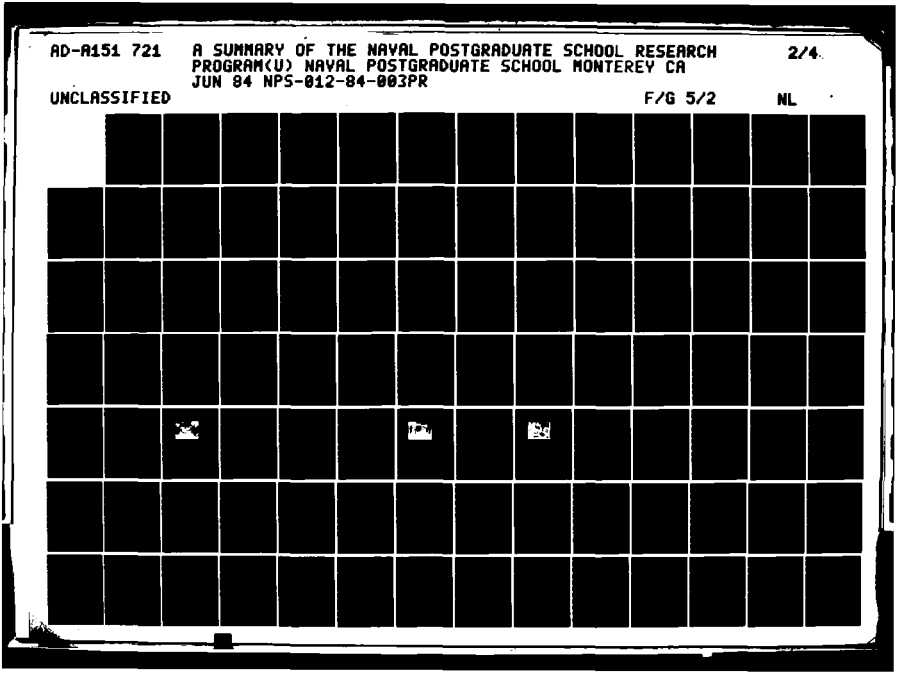
ofessor Poock continues his work in adapting available hardware
rm voice input of data to computers, with applications in Command,
and Communication. This work is sponsored by the Naval Electronics
Command.

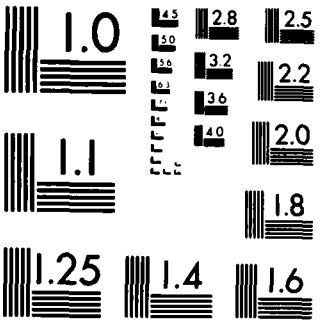
S AND SUPPLY

ofessors Richards, McMasters and Howard have continued development
ing of alternative wholesale models for the Navy's inventory control
ith the completion of the development of models for the provisioning
eapon systems. Their research is sponsored by the Naval Fleet Mate-
port office. Professor McMasters continued his research, sponsored
Supply Systems Command, into material distribution systems for
ea support by large wholesale activities.

AD-A151 721 A SUMMARY OF THE NAVAL POSTGRADUATE SCHOOL RESEARCH PROGRAM(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA JUN 84 NPS-012-84-003PR 2/4

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Title:	Tactical Development and Evaluation Program
Investigator:	A. F. Andrus, Associate Professor of Operations Research and Statistics
Sponsor:	Chief of Naval Operations: (OP-953) and Navy Tactical Support Activity
Objective:	Technical administration and quality control for contractor and Navy laboratory products in support of the Navy Tactical Development and Evaluation Program.
Summary:	Professor Andrus coordinated and evaluated the development of tactical decision aids for inclusion in the Fleet Mission Program Library. This library id developed under the direction of CNO (OP-953) and maintained by the Navy Tactical Support Activity.
Theses Directed:	D. Ourlian, "Optimal Positioning of Area Defense Cruisers Against Low Radar Cross Section Anti-Ship Cruise Missiles" (U), December, 1983 W. J. Mickler, Jr., "Screenop: A Computer Assisted Model for ASW Screen Design", October, 1983 D. B. McKinney, "MASK: A Tactical Aid for Planning Air Strikes Against Radar Defended Land Targets", October, 1983

Title: Detail to ONR Branch Office, London

Investigator: D. R. Barr, Professor of Operations Research and Statistics

Sponsor: Office of Naval Research

Objective: To conduct scientific liaison

Summary: Prominent European statisticians and researchers were visited for the purpose of discussing current research activities and trends.

Publications:

36-2:43-45	Using Asymptotic Expansions to Find Approximate Confidence Intervals
36-3:63-64	A. P. Dawid: Applied Philosopher
36-3:64-67	Statistical Computing at Rothamstead
36-4:86-88	Operations Research and Applied Systems Analysis at the University of Warwick
36-4:88-91	Risk Theory
36-5:110-111	The 7th Advances in Reliability Technology Symposium
36-5:110-113	The European Institute for Advanced Studies in Management
36-6:131-132	A Nuclear Material Accountability Model
36-6:132-136	Research in Statistics at the University of Kent at Canterbury
36-7:160-161	The Fourth Formator Symposium
36-7:161-163	The International Meeting on Analysis of Sample Survey Data and on Sequential Analysis
36-8:180-182	Experiments on Memberships in Fuzzy Sets
36-8:182-185	A Research and Development Decision Aid
36-9:225-227	Practical Bayesian Statistics
36-9:227-230	Statistical Research at Royal Holloway College
36-10:254-256	The Working Mathematics Group
36-10:261-263	Operations Research at IABG
36-10:270-273	The 15th European Meeting of Statisticians
36-11:302-304	International Reliability and Maintainability Conference
36-11:310-313	Reliability Work at the University of Bradford
36-12:343-346	Operations Research Applications on Microcomputers
36-12:354-356	Statistical Research at the University of Birmingham

Articles appeared in European Scientific Notes, 1982

37-1:25-27	A Systems Approach to Defense Analysis
37-1:27-30	Thames Barrier Become Operational
37-2:71-74	Management Science Research at Odense University
37-2:79-81	Megalithic Statistics
37-3:111-113	Computational Complexity Research
37-3:113-116	Statistics at the Technical University of Denmark
37-4:140-143	The Institute d'Administration des Entreprises
37-4:159-161	Statistics at Aachen
37-5:180-182	The 4th Euredata Conference
37-5:182-185	Northern British O. R. Conference
37-6:208-210	Computer Aided Instruction
37-6:232-234	Environmental Extremes Meeting
37-7:273-276	O. R. in an Engineering Production Department
37-7:285-287	Applications of the Multi-Armed Bandit
37-7:291	Remote Sensing Degree
37-8:337-340	Statistical Quality Control
37-8:341	Regression Software
37-9:370-373	European Congress on Operations Research
37-9:386-388	The International Statistical Institute
37-10/11:430-433	Statistics in Ireland
37-10/11:436	Royal Statistical Society

Articles appeared in European Scientific Notes, 1983

Reports:

Statistics, Operations Research, and Management Science in Europe - 1982
Summary Report, ONR London Report R-2-83 (1983)

Research Organization in the Federal Republic of Germany, ONR London Report (unnumbered), (1983)

Statistics and Operations Research in Europe - 1983 Summary Report, ONR London Report R-3-84 (1984)

Title: Large Scale Optimization

Investigators: G. G. Brown, Professor of Operations Research; G. H. Bradley, Professor of Computer Science

Sponsor: Office of Naval Research

Objective: Develop theory and algorithms for solution of large-scale optimization models.

Summary: The Naval Postgraduate School research program in large-scale optimization has continued with progress on several fronts. Optimization of generalized networks, networks with gains, fixed charge networks, and imbedded networks, has received further attention. Such models can now be solved nearly as efficiently as pure networks. Large-scale nonlinear and mixed integer models can now be solved in real time, with model generation facilities and report extraction tools permitting rapid response to analyst queries. New decomposition and relaxation methods for very large models have yielded extremely efficient solutions of complex mixed integer problems. More important, new theoretical insight has been gained in the convergence properties of these approaches.

Publications:

G. Brown, R. McBride and K. Wood, "Extracting Embedded Generalized Network Problems from Linear Programming Problems," Technical Report, School of Business, University of Southern California, June 1983.

G. Brown, G. Graves and M. Honczarenko, "Design and Operation of a Multicommodity Production/Distribution System Using Primal Goal Decomposition," NPS Technical Report, NPS55-83-010, May 1983.

G. Brown and R. McBride,"Solving Generalized Network Problems," Management Science, forthcoming.

G. Brown and B. Shubert, "On Random Binary Trees," Mathematics of Operations Research, forthcoming.

G. Brown, G. Graves and D. Ronen, "Scheduling Ocean Transportation at Crude Oil," Technical Report, University of Missouri, St. Louis,(May 1983).

J. Taylor and G. Brown, "Annihilation Prediction for Lanchester-Type Models of Modern Warfare," Operations Research, 31 (1983), p. 752.

G. Brown and G. Graves, "Real-Time Dispatch of Petroleum Tank Trucks," Interfaces, forthcoming.

G. Brown and W. Wright, "Automatic Identification of Embedded Network Rows in Large Scale Optimization Models," Mathematical Programming, forthcoming.

G. Bradley, G. Brown and G. Graves, "Structural Redundancy in Large-Scale Optimization Models," Redundancy in Mathematical Programming, M. Karwan et al, eds., Springer Verlag, 1983.

Conference Presentations:

G. Brown, G. Graves, and D. Ronen, "Scheduling Crude Tankers," TIMS/ORSA, Chicago, 25 April 1983.

G. Brown, G. Graves, and R. McBride, "Real-Time Dispatch of Petroleum Tank Trucks," TIMS/ORSA, Chicago, 26 April 1983.

Theses Directed:

D. Theune, "A Microcomputer-Based Linear Programming System," Master's Thesis, October 1983.

M. Finley, "An Extended Microcomputer-Based Network Optimization Package," Master's Thesis, October 1982.

D. Bausch, "Computational Advances in the Solution of Large Scale Set Covering and Set Partitioning Problems," Master's Thesis, October 1982.

P. Lord, "An Examination of the United States Air Force Optimal Nonnuclear Munitions Procurement Model," Master's Thesis, October 1982.

Title: The Optimal Search for a Moving Target when the Search Path is Constrained

Investigator: J. N. Eagle, Associate Professor of Operations Research

Sponsor: NPS Foundation Research Program

Objective: The objective of this research was to propose and investigate a partially observable Markov decision process (POMDP) technique for solving the discrete time and space moving target problem when the searcher's motion is subject to path constraints.

Summary: A search is conducted for a target moving in discrete time among a finite number of cells according to a known Markov process. The searcher must choose one cell in which to search in each time period. The set of cells from which he can choose is a function of the cell chosen in the last time period. The problem is to find a search path, i.e., a sequence of search cells, that maximizes the probability of detecting the target in a fixed number of time periods. The problem is formulated as a POMDP. A finite time horizon POMDP solution technique is suggested which is simpler than the standard linear programming methods.

Publications: J. N. Eagle, "The Optimal Search for a Moving Target when the Search Path is Constrained," NPS Technical Report, NPS55-83-014, August 1982, Revised May 1983.

J. N. Eagle, "The Optimal Search for a Moving Target when the Search Path is Constrained," Operations Research, forthcoming.

Thesis Directed: D. B. Guthe, "Optimal Search for the Wake of a Moving Target when Search Motion is Constrained," Master's Thesis, September 1983.

Title:	Computational Statistical Tools for Weather Forecasting
Investigator:	Donald P. Gaver, Jr., Professor, Distinguished Department of Operations Research
Sponsor:	Naval Environmental Prediction Research Facility
Objective:	The objectives of this project are to develop and apply novel computational-statistical and probabilistic methodologies for use in the analysis of weather conditions.
Summary:	Several statistical models and techniques are employed to forecast the existence of low-level stratus conditions at Moffett Field, California. The emphasis of the study is on single station short-range forecasting using surface meteorological measurements.
Publication:	Gaver, D. P. and Jacobs, P. A. "Low-level stratus prediction using binary statistical regression: a progress report using Moffett Field data". Naval Postgraduate School Technical Report NPS55-83-034., 1983. 78pp.

Title: Stochastic Modeling and Data Analysis

Investigator: Donald P. Gaver, Jr., Professor, Distinguished Department of Operations Research

Sponsor: Probability and Statistics Program, Office of Naval Research

Objective: The objectives of this project are to develop, apply, and test and validate new methods of statistical data analysis and probability modeling for solving problems arising in applications with special reference to problems in the Navy and the government and military in general.

Publications:

L. C. Thomas, P. A. Jacobs, D. P. Gaver, "Inspection policies for stand-by systems". In preparation.

D. P. Gaver, P. A. Jacobs, "Low-level stratus prediction using vinary statistical regression: a progress report using Moffett Field Data" Naval Postgraduate School Technical Report NPS 55-83-034.

D. P. Gaver, P. A. Jacobs, "Data Analysis and Modeling of Arctic Sea Ice Subsurface Roughness" Naval Postgraduate School Technical Report NPS 55-82-031.

D. P. Gaver, K. Kafadar, "A retrievable recipe for inverse "t", In preparation.

J. P. Lehoczky, D. P. Gaver, Performance Evaluation of voice/data queueing systems in Applied Probability -Computer Science The Interface. Volume I. (ed. R. L. Disney, T. J. Ott) Birkauser, Boston, 1982 pp 329-346.

D. P. Gaver, "Stochastic modeling: ideas and techniques" in Probability Theory and Computer Science ed. by G. Louchard and G. Latouche. Academic Press. 1983. pp. 3-49.

S. E. Shreve, J. P. Lehoczky, D. P. Gaver, Optimal consumption for general diffusions with absorbing and reflecting barriers. SIAM J CONTROL. To appear

(Continued)

Publications:

D. P. Gaver, R. G. Miller, Jr., Jackknifing the Kaplan -Meier survival estimates for censored data: simulation results and asymptotic analysis. Communication in Statistics. To appear.

M. Mazumdar, D. P. Gaver, A comparison of algorithms for computing power generating system reliability indices IEEE TRANS. on Power Apparatus and Systems, To appear.

Title:	Improvement of Instruction and Research in Tactical Analysis
Investigator:	Captain Wayne P. Hughes, Jr., USN
Sponsor:	Chief of Naval Operations
Objective:	To provide for faculty intersessional work to improve instruction in tactics and fleet operations analysis; for invitational travel to enhance this instruction; and for student and faculty travel in conjunction with tactics-related thesis research.
Summary:	(1) Professor Lindsey devoted half of one intersessional quarter to improving course material for the OT and E Course (OA 4603) (2) Ten members of the Tactical Training Group, Pacific traveled from San Diego to present a three-day Condensed Tactics Course to the Operations Analysis students and other selected students and faculty. (3) Eighteen student TAD trips for thesis research supported. (4) Eight faculty TAD trips supported. (5) Seven TAD trips by the incumbent were supported.
Conference Presentations:	Three day Condensed Tactics Course by the Tactical Training Group Pacific at USNPS, February 1983

Title:	Multivariate Time Series Analysis and Modelling of Oceanographic/Meteorological Data
Investigators:	P. A. Jacobs, Associate Professor of Operations Research, and P. A. W. Lewis, Professor of Operations Research
Sponsor:	NPS Foundation Research Program
Objective:	To develop the capability to examine time series graphically and statistically and to use the capability to analyze oceanographic and meteorological data.
Summary:	A graphical time series package using the IBM experimental graphics package GRAFST3 was developed. The developed time series package and GRAFST3 were used to examine meteorological and oceanographic time series.
Publications:	P. A. W. Lewis et al. "Docume· for graphical time series package." Forth g.
	P. A. Jacobs. "A pilot data anal·sis of sea surface temperatures and wind speeds me ed on oceanic weather ship PAPA - a summary." NPS Technical Report. In progress.

itle: CEMS Enhancement of OAP

ıvestigators: H. J. Larson, Professor of Operations Research and Statistics; T. Jayachandran, Associate Professor of Mathematics

ɔonsor: Kelly Air Force Base, Texas

ɔjective: Monitor performance of our algorithm in the CEMS IV prototype and suggest ways to enhance the oil analysis program by incorporation of CEMS parameters.

ɹmmary: A statistical algorithm was developed for generating computer recommendations for the spectimeteric oil analysis program (SOAP). This was implemented in the computer code for the CEMS IV base level prototype. This prototype is undergoing test and evaluation by the Air Force at Barksdale AFB. We are currently monitoring the performance of this algorithm and are examining other parameters in the CEMS IV data base for possible enhancement of the SOAP recommendations. We are making recommendations about the types of reports from the central data base, which would best serve the interests of the oil analysis program. We are participating in the Test and Evaluation of the CEMS IV base level data system.

Research on Sub-Saharan Africa was aided by a February 1983 conference on he Future of Relations between the United States and South Africa: Conflict Cooperation." In addition, continuing research on regional conflict in uthern Africa has resulted in a number of articles in books, journals and wspapers on strategies for limiting escalating conflict between South Africa d its neighbors. A new project is seeking to develop a new model of the reign policy behavior of third world states which will improve our general derstanding of the dynamics of international competition in Africa.

VIET AND EASTERN EUROPEAN POLITICO-MILITARY RESEARCH AND ANALYSES ACTIVITIES

Research projects completed by an NPS Smithsonian Scholar at the Woodrow lson International Center (May 1-December 31, 1983) dealt with analyses of viet military interventions at the periphery of the USSR, and Soviet rategic objectives in the Caribbean Basin as indicated by Soviet military tivities in Cuba, Nicaragua and El Salvador. Other, related topics included e development of a conceptual framework to analyze Soviet decisionmaking for tional security affairs. Four journal articles and three newspaper articles peared during FY83. In addition, presentations or participation in portant conferences were undertaken, and media appearances were involved on search topics. Two forthcoming books and several articles will appear early 1984.

In the general area of Defense Policy, and sponsored by the Inter-American velopment Bank and Jamaican Ministry of Planning, field research was mpleted and a forthcoming book was completed titled, Stabilization Efforts An Open Economy: The Jamaican Experience from Duke University Press. ven articles appeared in journals on economic models, state planning, and dustrial capabilities, while eleven other articles are forthcoming early in 84.

RATEGIC MILITARY DECEPTION

The multi-disciplinary research program to examine strategic thought ring World War II continues, a major portion of which examines strategic val thought during the Normandy and Pacific Campaigns. The "lessons arned" from these major confrontations are being probed to determine, in rt, any cause and effect relationships between strategic deception and the timate course of the conflict. An adjunct study examines the theory and actice of cross-cultural perception management.

NERAL INFORMATION

NSA faculty attended numerous national and international conferences, at ich they presented research papers, acted as rapporteurs, panelists, and derators. Substantial research efforts were involved in all major papers livered. The wide-ranging, impressive participation at these major nferences provides cross-fertilization and broad perspectives from prominent holars and high government officials.

DEPARTMENT OF NATIONAL SECURITY AFFAIRS

Research interests of faculty in the Department of National Security Affairs conform generally to the academic curricula offered, namely (1) Geographical Area Security Studies, including the Middle East, Africa, Asia, the Pacific Basin, Europe and the U.S.S.R, and (2) Functional Specialty Studies, including International Organizations and Negotiations, Strategic Planning, and Intelligence.

The research efforts span broad regional and functional spectra, focusing on the national and security interests of the United States with a congeries of major international entities such as states, alliances, blocs and organizations. Special emphasis is accorded the role of the military in worldwide cultural, economic, historical, legal, political and technological milieus which shape the global interests, capabilities and security policies of the United States.

Developments in the general areas of research are subsumed under the major headings which follow.

REGIONAL POLITICO MILITARY ANALYSIS

Analyses focus largely on those areas of vital concern to the United States, including Africa, Asia, Europe, and the Middle East/Southwest Asia.

In the European region, research on NATO, French and German politico - military challenges, strategic balance and arms control has been fruitful. No less than three books have been accepted for publication early in 1984, among them La France et la securite europeenne, Paris, Presses Universitaires de France, while fourteen articles appeared in major journals, and many chapters were selected for anthologies and edited conference reports. The wide-ranging research project on "French Security Policies," now funded by the Fritz Thyssen Foundation and Institute for International Studies, is a prolific source of forthcoming books and articles dedicated to advancing understanding of French policies and European security.

Research on Asian affairs was conducted in substantial measure in Hongkong, Korea and Japan and resulted in nine prestigious Journal articles, three reviews, and two forthcoming books, including the conference report on "The Role of the Military in Contemporary Asian Societies," from Duke University Press and a provocative analysis of the U.S.-Japan Mutual Defense Treaty from the Hoover Institution Press.

Research is underway on Japanese strategic thought and the modernization and transformation of the Chinese People's Army.

Publications stemming from substantial research in Middle East Studies include Responding to Crises in Southwest Asia: The RDF and Its Alternatives, forthcoming from the Hoover Institution Press, a Research Report, The Arab Gulf Cooperation Council: Threat Analysis and Strategic Implications, International Defense Intermetrics, 1983, seven journal articles, and newspaper background and perspective articles.

DEPARTMENT

OF

NATIONAL SECURITY AFFAIRS

Title: Reliability Evaluation of Binary Systems

Investigator: R. K. Wood, Assistant Professor of Operations Research

Sponsor: NPS Foundation Research Program

Objective: To develop and implement new techniques for evaluating the reliability of binary systems represented as networks and fault trees.

Summary: Special state-space partitioning techniques together with topological reduction and decomposition methods have been developed for computing source-to-K-terminal reliability in acyclic directed networks. Good lower bounds on reliability have been shown to be achievable by truncating exact calculations. Techniques for analyzing factoring algorithms for computing reliability in undirected networks have been extended to directed networks. A factoring algorithm for fault-tree evaluation has been devised and its implemetation begun.

Publications: R. K. Wood, "Factoring Algorithms for Computing Network Relability," NPS Technical Report, forthcoming.

A. Agrawal, R. K. Wood, and C. Lee, "Computing Source-to-K-Terminal Reliability in Directed Acyclic Networks," NPS Technical Report, forthcoming.

Conference Presentation: A. Agrawal, R. K. Wood and C. Lee, "Computing Source-to-K-Terminal Reliability in Directed Acyclic Networks," NSF Network Reliability Workshop, Stevens Institute of Technology, Hoboken, New Jersey, August 24-26, 1983.

Theses Directed: C. Lee, "Computing Source-to-K-Terminal Reliability in Directed Acyclic Networks," Master's Thesis, September 1983.

R. Robison, "A Factoring Algorithm for Fault Tree Evaluation," Master's Thesis, March 1984

R. H. Shudde, "A Multiple Leg TMA Procedure with Programs for HP-41CV, the HP-75C, the Sharp PC-15ØØ (TRS-8Ø PC-2), and the TRS-8Ø Model 1ØØ," NPS Technical Report, NPS55-83-025, September 1983.

R. H. Shudde, "Position Determination with LORAN-C Triplets Using the HP-75C, the Sharp PC-15ØØ and the TRS-8Ø Model 1ØØ," NPS Technical Report, NPS55-83-023, September 1983.

B. O. Shubert, "Some Probability Distributions Related to Classical Occupancy with Possible Applications to Tactical Analysis," NPS Technical Report, NPS55-83-019, July 1983.

A. R. Washburn, "ASW Operations in the Southwest Approaches to the English Channel (SWAP)(U)," SACLANTCEN, 19 September 1983.

A. R. Washburn, "Simple Calculations for a Semi-Configured Minefield (U)," NPS Technical Report, NPS55-83-011, May 1983.

Conference Presentations:

A. R. Washburn, "Benefits of Bell-Shaped Actuation Curves (U)," Proceedings of the 23rd Mine Development Conference, May 1983, Naval Surface Weapons Center, Report MP83-146, pp. 537-544.

Theses Directed:

D. Driskill, "An Application o the NAVSTAR Global Positioning System in Navigation Track Reconstruction for Naval Exercises,"Master's Thesis, September 1983.

R. K. Ford and J. Zarcharzuk, "Active Sonar Tactical Decision Aid," Master's Thesis, March 1983.

M. Morrell, "An Efficient Monte-Carlo Model of a Magnetic Minefield," Master's Thesis, March 1983.

J. Seely, Jr., "Optimum Processor Setting for the AN/SQR-18A Sonar System with Respect to Range Rate Doppler," Master's Thesis, September 1983.

S. G. Slaton, "A Computer Program to Model Passive Acoustic Anti-submarine Search Using Monte-Carlo Simulation Techniques," Master's Thesis, September 1983.

Title: Tactical Analysis

Investigators: A. R. Washburn, Professor and Chairman of Operations Research; J. D. Esary, Professor of Operations Research; R. N. Forrest, Professor of Operations Research and Chairman of ASW Group; J. N. Eagle, Associate Professor of Operations Research; B. O. Shubert, Associate Professor of Operations Research; and R. H. Shudde, Associate Professor of Operations Research

Sponsor: Office of Naval Research

Objective: This is a blanket contract to cover research in a variety of tactical areas. The objective in all cases is to aid in the construction of a scientific foundation for fleet tactics.

Summary;

1. Minefield Planning. Emphasis has been placed on the construction of fast, accurate, and preferably portable computational tools for evaluating uncountered minefields. Analytical approaches have resulted in a BASIC program that runs on a handheld computer and experience with a new type of simulation has been encouraging. The tactical role of mines in antisubmarine warfare has also been studied in one specific area.

2. Search Procedure Evaluation. This study is to determine how target detection time depends on various parameters associated with the search procedure. Work in 1983 concentrated on construction of a simulation to be used as "ground truth" in subsequent modelling. The objective is to use the simulation to calibrate less accurate but more convenient models.

3. Handheld Computer Evaluation. Programs to implement several target state estimation procedures and to perform LORAN-C navigational fixes were written and subsequently used to provide a comparative evaluation of a variety of handheld computers.

Publications:

R. N. Forrest, "Three Target State Estimation Programs," NPS Technical Report, NPS55-83-027, October 1983.

R. H. Shudde, "A Comparison of the HP-75C, the Sharp PC-15ØØ and the TRS 8Ø Model 1ØØ Computers Using a Large BASIC Program," NPS Technical Report, NPS55-83-024PR, September 1983.

Title: Lanchester-Type Models that Reflect Spatial Distribution of Forces

Investigator: J.G. Taylor, Professor of Operations Research

Sponsor: NPS Foundation Research Program

Objective: To formulate for tactical situations of interest Lanchester-type models that reflect spatial distribution of forces based on a continuum-mechanics approach to modelling combat and to investigate the development of analytical/numerical solutions to such distributed-parameter formulations.

Summary: Some Lanchester-type combat models that reflect the continuous (at least almost everywhere) spatial distribution of two homogeneous forces on a one-dimensional battlefield were developed. By combining ideas from traffic and combat theories, this work developed for modern combat between conventional-purpose ground forces a continuous-mechanics paradigm that explicitily considers both attrition and force movement. Attrition is modelled by a Lanchester-type continuity equation (actually an integro-partial-differential equation) for each side's force density, while movement is modelled by a functional relation between each side's velocity and the force densities, battlefield location, tactical-decision variables, and force-movement strategies. An exact analytical solution in a special case of tactical interest (attrition occurring only for forces in direct contact) was developed by means of Riemann's method for the special case in which each spatially-distributed force moves with its own constant speed at all locations on the one-dimensional battlefield.

Publications: J.G. Taylor, "Lanchester-Type Models that Reflect Continuous Spatial Distribution of Forces," pp. 302-312 in Modelling and Simulation of Land Combat, L.G. Callahan (ed.), The Georgia Tech, Research Institute, Atlanta, GA, 1983.

J.G. Taylor, "Analytical Solution to a Lanchester-type Combat Model that Reflects the Continuous Spacial Distribution of Forces with Constant Force-Movement Speeds," submitted to Int. J. Systems Science.

J.G. Taylor, "Some Lanchester-Type Combat Models that Reflect Continuous Spatial Distribution of Forces," submitted to Naval Research Logistics Quarterly.

Conference Presentation: J.G. Taylor, "Soviet Methodological Advances in Combat Modelling," TIMS/ORSA Chicago Meeting, Chicago, IL, 26 April 1983.

Title:	Wholesale Provisioning Model for the Provisioning Prototype
Investigators:	F. R. Richards, Associate Professor of Operations Research; A. W. McMasters, Associate Professor of Operations Research and Administrative Sciences; G. T. Howard, Associate Professor of Operations Research
Sponsor:	Navy Fleet Material Support Office
Objective:	This is a continuing research effort to develop an improved wholesale provisioning model for the U. S. Navy.
Summary:	The existing models and guidelines used for wholesale provisioning of new weapon systems within the Navy were documented and programmed. Three alternatives were then developed. The three decision criteria were supply material availability, mean supply response time, and operational availability. For each criteria, a spares allocation algorithm was developed, programmed, and used to allocate spares optimally subject to the DODI 4140.42 cost constraints. Actual provisioning data have been obtained and will be used to evaluate the new models. Preliminary model results indicating significant improvements in effectiveness were presented to the sponsor.
Publication:	F. R. Richards and A. W. McMasters, "Wholesale Provisioning Models: Model Development, " NPS Technical Report, NPS55-83-026, September 1983.
Thesis Directed:	S. J. Kang, "Analysis of Inventory Models with Budget Constraints, " Master's Thesis, September 1983.

Title: Basic Human Characteristics Correlated with Voice Recognition.

Investigator: G.K. Poock, Professor of Operations Research and Man-Machine Systems

Sponsor: NAVELEX

Objective: To examine empirical data collected in experiments to see if there is any correlation between various human characteristics and the human's performance on an automatic speech recognition machine. In addition, basic issues of time stress and psychological stress were examined.

Summary: Experiments were conducted with military personnel as subjects in a variety of scenarios. Some fifty variables were examined for correlations between human characteristics and speech recognition system performance. Time stress and physiological and psychological stress were also found to have an effect on speech recognition performance.

Publications:

Howard Yellen, "A preliminary analysis of human factors affectins the recognition accuracy of a discrete word recognizer for C3 systems", Masters thesis, Naval Postgraduate School, March 1983.

Brian French, "Some effects of stress on users of a voice recognition system: - A prelimanary inquiry", Naval Postgraduate School, Masters thesis, March 1983.

Gary K. Poock and B. Jay Martin, "Effects of emotional and perceptual-motor stress on a voice recognition system's accuracy: An applied investigation", Naval Postgraduate School Technical Report NS55-84-002, February 1984.

Title:	Basic Requirements for Voice Input into the Intesrated Information Display (IID) System
Investigator:	Gary K. Poock, Professor of Operations Research and Man-Machine Systems
Sponsor:	NAVELEX
Objective:	To examine the feasibility of, and potential uses for the use of automatic speech recognition equipment as a means of data and command entry into the IID system.
Summary:	The basic feasibility study was successfully completed and showed it was possible to interface current state of the art speech technology into the IID. In addition, automatic speech recognition equipment was actually installed on-line on the IID in the Navy command center in Pearl Harbor.
Publication:	Gary K. Poock and Ellen F. Roland, "A feasibility study for intesrated Information Display System (IID)", Naval Postgraduate School Project Report NPS55-84-008PR, March 1984.

Title: U. S. Army Manpower/Personnel Project

Investigator: P. R. Milch, Professor of Operations Research

Sponsor: U. S. Army Military Personnel Center

Objective: To establish a research project involving both faculty and Army students to work on Army personnel/manpower problems.

Summary: Two problems were selected from a list of topics suggested by the sponsor:

1. The Personnel Readiness Indicator Model. An initial model was constructed that has the potential to predict the future personnel readiness of Major Commands (MACOM's) of the U. S. Army. This prototype model involves only soldiers with one of the several hundred military occupational specialties (MOS's) located at five of the most important MACOM's. The model involves forecasting future end strengths via a Markov Chain model and distributing new accessions (and personnel making permanent change of station moves) to MACOM's in an optimal sense. "Optimal" here means maximizing the smallest percentage fill among all skill level personnel in all five MACOM's, subject to availability of personnel and Army requirements about minimum (and maximum) percentage fills. "Percentage fills" refers to the ratio of available to authorized numbers of personnel in each skill level and MACOM.

2. Airborne Model. An initial model was constructed to predict future training requirements in the Airborne Community for personnel with secondary qualification indicators (SQI's). This prototype model involves soldiers with one of only two of the about two dozen career management fields (CMF's) in the Airborne Community. The model computes the required number of personnel to be trained of the three Airborne SQI's (parachutist, ranger and special forces) over the next several years, subject to limited training class sizes and overall training budget size.

Theses Directed: C. S. Thomas, "Forecasting U. S. Army Major Command Readiness Based on Enlisted Personnel Strength," Master's Thesis, December 1983.

D. B. Chung, "The Forecasting of Future Inventory and the Optimization of Training Requirements within the Airborne Community," Master's Thesis, December 1983.

Title:	NPS Support for Technical Analysis of USMC Operational Data
Investigator:	G. G. Lindsay, Associate Professor of Operations Research
Sponsor:	United States Marine Corps
Objective:	To establish a program of general technical support for USMC analysis of data from operations.
Summary:	USMC training operations were surveyed to ascertain the nature of the data which is currently gathered as part of these operations, and to analyze the utility of this information in support of USMC missions. Where appropriate, possible additional data sources were identified in terms of the potential contribution to what can be learned from operations.

Publications:

P. A. Jacobs and P. A. W. Lewis, "Stationary Discrete Autoregressive-moving Average Time Series Generated by Mixtures," Journal of Time Series Analysis, Vol. 4, 1983, p. 19-36.

A. J. Lawrance and P. A. W. Lewis, "Generation of some first-order autoregressive sequences of random variables with given marginal distributions," in Vol. 1. Proceedings of Applied Probability and Computer Science Conference, R. Disney, Ed., Birhkauser, Boston, 1983, P. 353-379.

A. J. Lawrance and P. A. W. Lewis, "A Mixed Exponential Time Series Model," in Management Science, Vol. 28, No. 9, 1983, p. 1045-1053.

P. Heidelberger and P. A. W. Lewis, "Quantile Estimation for Dependent Sequences," Operations Research, forthcoming.

A. J. Lawrance and P. A. W. Lewis, "Simple Dependent Pairs of Exponential and Uniform Random Variables," Operations Research, forthcoming.

P. A. W. Lewis, E. J. Orav, H. W. Drueg, D. G. Linnebur and L. Uribe, "SIMTBED: A Graphical Test Bed for Analyzing and Reporting the Results of a Statistical Simulation Experiment," NPS Technical Report, NPS55-83-007, April 1983.

P. A. W. Lewis, E.J. Orav, H. W. Drueg, D. G. Linnebur, and L. Uribe, "SIMTBED: A Graphical Test Bed for Analyzing and Reporting the Results of a Statistical Simulation Experiment," International Statistic Institute, forthcoming.

A. J. Lawrance and P. A. W. Lewis, "Stationary Exponential Time Series: Further Model Development and Residual Analysis," NPS Technical Report, NPS55-83-008, April 1983.

L. C. Breaker, P. A. W. Lewis, and E. J. Orav, "Analysis of a 12-year Record of Sea-Surface Temperatures off Point Sur, California," NPS Technical Report, NPS55-83-018, June 1983.

Title: Stochastic Modelling, Time Series Analysis and Simulation

Investigator: P. A. W. Lewis, Professor of Statistics and Operations Research

Sponsor: Office of Naval Research

Objective: The purpose of this research is to develop models for time series and stochastic point processes, develop new statistical methodology for use in the simulations which are required in mathematical statistics and in the analysis of stochastic systems, and to develop methods for the analysis, display and editing of large scale, non-normal time series.

Summary:

1. A structure in exponential variables which gives second and third-order exponential autoregressive processes has been extended to higher order autoregressions and to time series with Laplace margins.

2. Several methods for doing residual analysis for non-normal time series with autoregressive correlation structure have been discovered. This should have wide applications in applied sciences like hydrology, meteorology, and oceanography.

3. A whole new class of simple models for discrete valued time series have been discovered.

4. The Beta-Gamma transformation has been used to extend the new Gamma time series model [GLARMA(p,q)] and the problem of obtaining maximum likelihood estimates in the first-order case has been solved.

5. Some of the exponential time series work has been applied to the delineation of simple multivariate exponential random variables. This should be useful in simulation and reliability studies.

6. Fifteen years of wind velocity data from Ship P has been analyzed and modelled with a non-stationary version of the Gamma model. This work has been extended to examine air temperatures and sea surface temperatures.

7. Work using "almost Differencing" to improve output analysis in system simulations has been initiated.

8. Extensive sets of sea surface temperature and temperature profile data have been examined. This has let some new insights into ocean dynamics and proposals for further work.

Title:	Soviet Pricing and Measures of Soviet Defense Related Costs
Investigator:	Steven Rosefielde, Adjunct Research Professor of National Security Affairs
Sponsor:	Directorate for Budget and Finance
Objective:	To quantify the full cost of Soviet defense spending
Summary:	The full cost of Soviet defense including basic military activities, subsidies, civil defense, hardening and prolonged war expenditures absorbs 20 to 25 percent of Soviet GNP
Conference Presentation:	American Association for the Advancement of Slavic Studies, Kansas City, MO, October 22, 1983

DEPARTMENT

OF

PHYSICS

DEPARTMENT OF PHYSICS

Research in the Department continued both in interdisciplinary projects and in more traditional subjects. In addition to the permanent staff, the research effort has benefitted from the presence of a number of visiting scientists, including Dr. E. F. Carome, the holder of the Chair of Applied Physics; Mr. R. A. Smith, an NSTEP selectee from NSWC; Postdoctoral Fellows Dr. M. M. Jakas and Dr. S. W Yoon; Adjunct Professors K. C. Dimiduk and J. C. Novarini; and a number of research-sponsored, high-level personnel.

ACOUSTICS

Professors J. V. Sanders and A. B. Coppens are continuing their investigations of the propagation of acoustic waves in shallow water. Modeling of propagation from a fluid wedge into a fast bottom and within the water has been continued using the method of images. Propagation up-slope, down-slope, and cross-slope in the wedge is being studied. A scale-model experimental facility for investigation of propagation along regularly slumping bottoms has been constructed, and another facility more suitable for irregular profiled bottoms is being implemented.

Professor O. B. Wilson, Jr., has returned from Orlando, Florida, where he was engaged in a Navy-sponsored book-writing project. The book, "Introduction to the Theory and Design of Transducers for Underwater Sound", is to be published during the coming year. The investigations of ambient noise in the ocean carried out two years ago in collaboration with the Naval Research Laboratory are being reactivated.

Professor Steven L. Garrett is engaged in several conventional underwater acoustical projects involving transducers: design and testing of fiber optic gradient hydrophones in collaboration with Dr. E. F. Carome; design of an automated sonar hydrophone testing facility to improve the shading of arrays; and reciprocity calibration in unusual geometries. This latter project, using resonant calibrators in gases, was begun with LCDR C. Burmaster and will be continued in water using both rigid and compliant slow-wave resonators.

Additionally, Professor Garrett has moved into the space environment Along with CDR Chuck Stehle and LT Scott Palmer, he has a "get-away special" project on the space shuttle to measure the vibroacoustic environment in the cargo bay. An acoustic refrigeration scheme for cooling space-borne detectors is also under development.

ELECTRO-OPTICS

Research concerning the optical properties of the atmosphere has continued with Professors Eugene C. Crittenden, Alfred W. Cooper, Edmund A. Milne, G. Wayne Rodeback, and their students.

Work was carried out for the Army Missile Command (MICOM) at Redstone Arsenal, Huntsville, Alabama, during FY83 to provide them with an improved system for determining the effects of turbulence on the performance of optical equipment on their optical range.

Previous work at NPS had provided the basis for determining C_n^2 for the atmosphere by means of measurement of the Optical Transfer Function (OTF) for imaging through the atmosphere. Joint experiments by NPS and MICOM had proven the earlier equipment on the optical range at MICOM. This has performed well for several years, but recent work at NPS has improved the system and indicated some further improvements that could be applied. The work involved design and construction of the new equipment at NPS and testing it in the corridor range in Spanagel Hall. Subsequently, the equipment was delivered to MICOM at Redstone Arsenal.

In work done under the sponsorship of the Pacific Missile Test Center, equipment developed in previous years was used to measure the optical turbulence on a path between an airplane and the ground. The results confirm that such measurements can be made on a real-time basis. The system has been reprogrammed to measure optical extinction as well as optical turbulence and will be tested in the near future. The sponsor is using the results of these measurements to analyze the performance of equipment under test.

Another optical physicist, Professor Donald Walters, joined us from White Sands Proving Ground. Professor Walters, who had been carrying out determinations of the isoplanatic angle at White Sands, is building up a laboratory to continue these important measurements.

LASER AND PLASMA PHYSICS

Professor Fred Schwirzke has continued his work on the investigation of the breakdown and unipolar arcing which occur when a laser beam interacts with a target surface. Unipolar arcing is an electrical plasma-surface interaction process which leads to crater formation, usually called laser-pitting. At low irradiance, this is the only observable type of laser-target interaction. With support from NRL, measurements of laser-induced unipolar arcing have been carried out on a variety of materials.

LINEAR ELECTRON ACCELERATOR

At the LINAC, experimentation has continued on Cerenkov radiation, and new work on radiation effects has begun. The Cerenkov radiation produced by the LINAC electron beam traveling in air was found to reflect the spatial structure of the electron beam. That is, since the electron bunches are periodic in space, the Cerenkov radiation has a fundamental frequency corresponding to this spacing along with its harmonics. Experiments and calculations of microwave Cerenkov radiation are continuing under the sponsorship of NAVSEA. Calculations of the time development of Cerenkov radiation have begun.

Professor Buskirk has temporarily left the group in order to spend a year at Los Alamos National Laboratory, where he will continue working in the general area of radiations from charged beams. In his absence, Dr. Xavier Maruyama from the Accelerator Division at the National Bureau of Standards will be joining the group. Dr. Maruyama is a former military instructor at NPS and is well known to the Physics faculty.

A new adjunct Professor, Kathryn C. Dimiduk, joined the staff in August 1983. At Stanford, Prof. Dimiduk carried out her Ph.D. thesis on the properties of the semiconductor HgCdTe, which is a production IR detector. Characterization of this material and others under electron irradiation has begun using the LINAC as a source. Fiberoptic components obtained from NOSC are also being characterized and irradiated.

ATOMIC PHYSICS

Professor Raymond Kelly has continued to operate the Spectroscopic Data Center with support from NASA and NBS. His compilation of spectroscopic data has continued to be an important source of data for researchers everywhere and is constantly used in the areas of high-temperature plasmas and solar physics.

A compilation of vacuum ultraviolet (VUV) spectral lines below 2000Å for all elements between hydrogen and argon was published in 1982. A new work covering the elements from potassium to krypton is to be published in 1984.

Current plans are to extend the VUV spectral line compilation to elements beyond krypton.

EXPLOSIVE CHEMISTRY

Professors Richard Reinhardt and Gilbert Kinney have continued their work, sponsored by the Naval Weapons Center and the Naval Surface Weapons Center, on the subject of chemical equilibria and overpressures resulting from the internal explosions of conventional and explosive fuels in the presence of reactive metals.

Calculations were performed for the temperature, pressure, and product yield expected for the adiabatic internal explosion of aluminum-loaded PBX material in air. Calculations were begun for the related problems for magnesium plus aluminum. This is a long-term project which is expected to continue.

SURFACE PHYSICS

The work of Professor Don E. Harrison, Jr., on the effects of ion bombardment has continued. Dr. Mario M. Jakas has replaced Dr. Roger P. Webb as a postdoctoral fellow, and the project has continuing support from ONR as part of a Special Research Opportunity.

The direction of the research continues to be that of using classical trajectory simulations to model the cascade produced by an ion impact event. Each atom in the resulting cascade can be followed during the simulation and statistical analysis of the results produces members which can be directly compared to the experimental data resulting from Secondary Ion Mass Spectroscopy (SIMS). The scattering work done in conjunction with investigators from SRI and the FOM Laboratory in Amsterdam is continuing.

ENVIRONMENTAL PHYSICS

The Environmental Physics Group continues as a joint project of the Physics and Meteorology Departments. Professors Kenneth Davidson and Gordon Schacher, who direct the group, have been joined this year by Professors Shaw, Larsen, and Takle. Larsen is from Riso National Laboratory, Denmark, and Takle is from Iowa State University; both are here on temporary appointments.

The group continues basic and applied research in atmospheric physics and meteorology, concentrating its efforts on modeling for overwater and coastal regions. Current major programs are properties of the marginal ice zone and diffusion in complex terrain. In both programs, the modeling work is supported by extensive field measurements. This description concentrates on the diffusion work; descriptions of other work appear in the Meteorology Department report.

Vandenberg AFB is the location of a group project to determine the characteristics of turbulence in complex terrain. Data is being acquired at twelve sites, from thirty wind speed/direction sensors, with a sampling rate of 1 Hz. Means and standard deviations of the vector components of the wind are recorded, and the data can be used to obtain averages from 15 seconds to as long a period as desired. This allows all scales of turbulence that are important for atmospheric diffusion to be investigated. One full year of data is being acquired so that statistical validity can be established for a wide range of conditions. These data are being used for site-specific modeling for the Space Shuttle program and to establish the general nature of diffusion in complex terrain.

In past years, the group has participated in a number of overwater diffusion experiments. These data are being used to parameterize overwater models for CBWD threat assessment. This work has been completed for standard surface layer meteorological parameters and will be completed for parameters that characterize the full boundary layer.

One especially interesting project is the characterization of the turbulence structure at the hydrogen flame stacks at the Vandenberg Space Shuttle launch site. The purpose is to determine if air motion in the area can transport the flame so as to cause it to be a hazard to operations.

The group will expand its modeling efforts, based on the large data base it is developing. It is expected that two additional people will be added to the diffusion program in the coming year.

Title:	Acoustic Propagation from a Fluid Wedge into an Underlying Fluid Substrate of Greater Sound Speed.
Investigators:	Alan B. Coppens, Associate Professor of Physics James V. Sanders, Associate Professor of Physics M. Humphries, Adjunct Professor of Mathematics
Sponsor:	NPS Foundation Research Program
Objective:	To formulate theoretical expressions based on a method of images approach to the propagation of sound in a wedge which will describe the sound field generated in the underlying fluid layer.
Summary:	The method of images was used to calculate the pressure on the interface between the wedge and the layer. The Green's function integral was then used to predict the sound field in the substrate. Evaluation was accomplished with the help of the saddle point integration methods and and end point method. A random phase approximation provided a simple closed form for the sound beam in the bottom which was in good agreement with other theoretical approaches to the problem. The various expressions were analyzed to determine phase coherent interference effects and quantitative agreement with methods based on solutions to the Parabolic Equation and with methods based on variations of matched asymptotic expansions.
Publications:	A. B. Coppens, M. Humphries, and J. V. Sanders, "Propagation of a sound beam out of a fluid wedge into an underlying fluid substrate of greater speed," submitted to Journal of the Acoustical Society of America.
Conference Presentations:	A. B. Coppens and M. Humphries, "Coherence and the beam of sound projected into an acoustically fast fluid bottom from an overlying sound-bearing wedge," 105th Meeting of the Acoustical Society of America, J. Acoust. Soc. Am. Suppl. 1, 73, S68 (1983)

Title: OTF Slit Scanner

Investigator: Eugene C. Crittenden, Jr., Distinguished Proffessor, Department of Physics

Sponsor: U. S. Army Missile Command

Objective: Development of an improved technique and equipment for the measurement of the optical effects of atmospheric turbulence.

Summary: An improved slit scanning telescope was developed for the measurement of the optical effects of atmospheric turbulence. The use of an anamorphic field lens system permits tracking within a wide field of view. The system was constructed and was tested in the NPS 135 meter indoor optical range and then sent to Huntsville for use in experiments on their outdoor range.

Publications: Eugene C. Crittenden, Jr., Edmund A. Milne, and G. Wayne Rodeback, "NPS Optical Slit-Scanning Telescope System for Measurement of C_n^2", NPS Technical Report No. NPS-61-84-011, June, 1984.

Title: Absolute Electroacoustic Measurement of Temperature Variations in Superfluid ^{4}He.

Investigator: S. L. Garrett, Assistant Professor of Physics

Sponsor: NPS Foundation Research Program

Objective: To test an extension of the reciprocity theorem for absolute electroacoustic calibration to mechanical, reversible, thermal (second) sound transducers in a quantum fluid.

Summary: An experiment was performed which has verified for the first time an extension of the reciprocity calibration technique to reversible thermal transducers in superfluid helium. A plane-wave resonator of circular cross-section was capped at both ends by reversible teflon slit-electret diaphragms to generate or detect thermal waves. The resonator also incorporated a heater and a d.c. - biased carbon resistance thermometer to set independent upper and lower limits on the thermal excursions within the resonatory. The tempeature excursions measured by the reciprocity method fell between the upper and lower limits, which, for lower modes, were separated by only a few percent. For higher modes, the lower limit departed from the upper limit due to the thermal inertia of the resistance thermometer, but the reciprocity result remained only a few percent below the upper bound set by the thermophone over nearly a decade in frequency. The "slit-electret" transducers had sensitivities in excess of 100 V/°K, and temperature oscillations as small as 10^{-10} °K/(Hz/$^{1/2}$) were detectable.

Publications: S. L. Garrett, "Reciprocity Calibration of Second Sound Transducers in Superfluid ^{4}He", Physical Review B, in progress.

J. Valdivia, Jr., R. B. Ogg, and S. L. Garrett, "Absolute Electroacoustic Measurement of Temperature Oscillations in Superfluid ^{4}He by the Reciprocity Method", Physical Review Letters, in progress.

Title: Fiber Optic Sensor Systems

Investigator: S. L. Garrett, Assistant Professor of Physics and E. F. Carome, Visiting Professor of Physics

Sponsor: Office of Naval Research

Objective: To construct and test several optical fiber interferometric sensor systems to initiate fiber optic sensor research and development work at NPS. This program continues into the next year.

Summary: In this phase of the project, we have constructed a He-Ne laser based interferometer (630nm) and an infrared pigtail diode laser interferometer (830nm) sensor system using all fiber light paths in a Mach-Zender geometry. Our initial sensor experients have been in the area of pressure and pressure gradient hydrophones. We constructed a "slow wave" calibrator to measure the performance of these hydrophones at low frequencies in the laboratory and found sensitivities which were consistant with calculation based on published values of the material parameters.

Thesis Directed: G. B. Mills, "Fiber Optic Gradient Hydrophone", Master's Thesis, in progress.

Title:	Reciprocity Calibration in Unconventional Geometries (Phase II).
Investigator:	S. L. Garrett, Assistant Professor of Physics
Sponsor:	Office of Naval Research
Objective:	This project is part of a continuing program designed to test the internal self-consistancy and absolute accuracy of extensions of the reciprocity method for calibration of electroacoustic transducers beyond the traditional geometries.
Summary:	During this phase of the work we were successful in constructing and testing fully automated systems which make reciprocity calibrations of electroacoustic transducers in planewave resonators and under free field conditions. We have demonstrated a precision and absolute accuracy of +0.05dB in air and expect to reduce this to 0.01 dB in the near future.
Publications:	D. V. Conte and S. L. Garrett, "Computerized Measurement and Tracking of Acoustical Resonances", IEEE - Transactions on Acoustics, Speech, and Signal Processing, under review.
Conference Presentations:	D. V. Conte and S. L. Garrett, "Computerized Measurement and Tracking of Acoustical Resonances", ASA Fall Meeting, Orlando, FL., November 8-12, 1982. Journal of the Acoustical Society of America 72 (Nov. 1982) p. S82.
Thesis Directed:	D. V. Conte, "Computerized Measurement and Tracking of Acoustical Resonances", Master's Thesis, December 1982. DTIS Report AD-A125 286.

R. B. Ogg, J. Valdivia, Jr., and S. L. Garrett, " A Simple Electret Transducer for Second Sound in Superfluid Helium", Review of Scientific Instruments, in progress.

Conference Presentations:

S. L. Garrett, "Reciprocity Calibration of 'Second Sound' Transducers in Superfluid Helium", ASA Fall Meeting, San Diego, California, November 8-12, 1983; Journal of The Acoustical Society of America 74 (Fall 1983) p. S26.

B. R. Ogg, J. Valdivia, Jr., R. K. Yarber, and S. L. Garrett, "Absolute Electroacoustic Measurement of Temperature Oscillatins in Superfluid ^{4}He by the Reciprocity Method", American Physical Society Fall Meeting, San Francisco, California, 20-23 November, 1983; IEEE Ultrasonics Symposium, Atlanta, Georgia, October 31 to November 2, 1983; IEEE-G-1983 Sonics and Ultrasonics Proceedings, in press.

J. Valdivia, B. R. Ogg, R. K. Yarber, and S. L. Garrett, "An Experimental Test of Acoustica Reciprocity Calibration Applied to Thermal Transducers in Superfluid Helium", ASA Fall Meeting, San Diego, California, November 8-12, 1983; Journal of the Acoustical Society of America 74 (Fall 1983) p. S26.

Thesis Directed:

R. R. Ogg and J. Valdivia, Jr., "Absolute Electroacoustic Measurement of Temperature Oscillations in Superfluid Helium by the Reciprocity Method", Master's Thesis, December 1983.

Title: Classical Trajectory Simulation Studies of Ion-Beam Bombardment Damage on Clean and Reacted Single Crystal Surfaces

Investigators: D. E. Harrison, Jr., Professor of Physics with Roger P Webb, Post Doctoral Associate (Dr. Webb left the project in July 1983 and was replaced by Dr. Mario M. Jakas, Post Doctoral Associate, who arrived in August 1983.)

Sponsor: National Science Foundation, Naval Postgraduate School Foundation Research Program and Office of Naval Research

Objectives: Continue study of the effects produced when ions bombard clean and chemically reacted single crystal metal surfaces to understand mechanisms and coordinate with experimental investigations. Study damage produced in target surface by bombarding ions.

Summary: Classical trajectory simulations have developed to the point that if is feasible to model the cascade produced by an ion impact event. The ability to follow each individual atom in the cascade leads naturally to pictorial interpretations of a single sputterng event. Statistical analysis of data produces numbers which can be directly compared to the experimental data. The model computations are done using single crystal targets oriented to expose the low index surfaces. Research effort this year has concentrated on the damage produced in the target surface by the bombarding ion. A color movie was produced to illustrate damage producing mechanisms studies of bombardment by molecular ions; studies of nitrogen reacted tungsten and molybdenum; and oxygen reacted titanium have been initiated. Dr. Jakas is begining to use the ion scattering program to study molecular ion scattering. A collaborative effort has begun with Prof. Peter Haff of Cal. Tech and Prof. Mark Shapiro of Cal. State, Fullerton.

The scattering work done in conjunction with investigators from SRI and the FOM Laboratory in Amsterdam is continuing.

Publications: D. E. Harrison, Jr., "Sputtering Models - A Synoptic View", Radiation Effects, 70, 1-64 (1983).

R. P. Webb and D. E. Harrison, Jr., "Computer Simulation of Ion Bombardment Pit Formation in Metals", Physical Review Letters 50, 1478-80 (1983).

Conference Presentations: Invited Paper and Contribution Paper: Ion Beam Analysis IV, Tempe Arizona May 1983.

Thesis: W. A. Mason, "An Investigation of Cascade Energy Density Effects Using Classical Trajectory Simulations of Sputtering by Molecular Ions", Master's Thesis, June 1983.

Professor Michael Morgan continued his investigations into Natural Resonance Radar Target ID sponsored by ONR and in Radar Cross Sections via Transient Measurements under DARPA sponsorship. There has been continued improvement of a new computerized experimental scattering facility which uses a very short baseband impulse to illuminate targets of interest. Development of optimal signal processing algorithms for this purpose continues.

Professor Morgan also continued his project on transient scattering and signal processing concerning the optimum synthesis of radar cross section (RCS) from transient measurements of scattering. Three tasks received considerable work. They were (1) study concerning s-plane RCS measurement not in the theoretical far-field (2) study of physical SEM representation of target transient response in the early-time while under driver excitation and (3) development of an optimal theoretical technique for system deconvolution for use for scatterer impulse response synthesis.

Professors Harold Titus and Alex Gerba have worked on development of Kalman filtering and smoothing of target tracking of actual range data for the Naval Torpedo Station Research and Engineering Department in Keyport, Washington. An algorithm was developed to smooth all past filtered estimates and simulated torpedo test runs demonstrated that smoothed estimates of states were better than or equal to the filtered estimates. The Extended Kalman Filter and the Optimal Smoothing Estimator were applied to actual torpedo run data with limited success and work is continuing in the effort to fully implement the program for installation on the tracking range computer.

Professor Donald Stentz under the sponsorship of the Naval Undersea Warfare Engineering Station at Keyport, Washington, has investigated the readiness of the surface fleet to perform a screening mission, and ultimately deliver a rocket thrown torpedo launched by destroyers (ASROC) within striking distance of the target. The goal was to correlate data from Fleet Operation Readiness Accuracy Check Sites (FORACS), and Ship ASW Readiness/Effectiveness Measuring Program (SHAREN) exercises to determine whether the weapon systems on the fifty-six ships involved were within acceptable calibration limits at the time of the exercise and should have been expected to detect, locate and place a weapon within striking distance of the target.

Professor Stentz has also been investigating the Mobile Acoustic Tracking Range (MATR) proposed by NUSC. The goal is to investigate current and near future technology in various fields and disciplines to see if it will be useful when applied to the proposed tracking range.

Professor Lonnie A. Wilson's continuing project on Automatic Radar Ship Classification for Cruise Missiles has developed several new ship target classification algorithms. The algorithms have been successfully tested on a small number of ship targets.

COMPUTER ENGINEERING

Professor Chin-Hwa Lee continued his project on computer region segmentation of aerial photographs. A recursive splitting at hierarchical scopic levels has been implemented. The proposed solution will be tested on digital imagery sets and additional experimental results collected to evaluate the effectiveness of the solutions.

Investigations of fluctuations of geomagnetic fields are being continued Professors Paul Moose and Otto Heinz (PHYSICS). Digital telemetry links m a spar-bouy connected to the sea floor sensors were installed. The sea- or sensor has been connected to the spar bouy by a fiber optic link designed constructed by two of Professor Powers' students. Data reduction is con- trating on production of power spectral densities. However, preliminary lysis of the geomagnetic fields' polarization properties indicates this may a fruitful area for further research.

MUNICATIONS

In collaboration with investigators outside NPS, Professor Glen Myers has sured performance of a delay-lock tracking loop where noise power exceeded nal power. Work included design, construction, operating and testing of a ventional delay-lock tracking loop. Professor Myers has also measured formance of: an asynchronous receiver used to recover binary data when the rier is noise; a simple integrated circuit used to generate arbitrary posite amplitude and phase-shift keyed sinusoidal couplers; and of a munications system using frequency hopping to provide improved ECCM.

Experimental investigations of dynamic routing and control algorithms for tributed packet radio networks are being conducted by Professor John encraft. The method of analysis involves the simulation of moderate sized works using the Simscript computer language.

Adjunct Professor Daniel Bukofzer conducted analysis of a receiver in the sence of noise and an intentional interference signal and examined detection a periodic signal with random phase in additive noise under low SNR con- ions. The goal is to analyze the vulnerability of receivers to jamming, and d ways (i.e., design optimum receivers) that are able to operate in the sence of a jammer. Results have been obtained for standard modulation vices, such as PSK and FSK, by evaluating receiver probability of error in presence of various jamming strategies.

Professor Lawrence J. Ziomek initiated a project on underwater acoustic pagation and scattering in a random ocean using a linear systems theory proach. Problems in pulse propagation, underwater acoustic communication and get detection will be studied via computer simulation of the derived math- tical expressions. Some progress has been made and work continues.

AR AND ELECTRONIC WARFARE

Adjunct Professor Stephen Jauregui's work to categorize type and level of se and interference at communication sites continues. Measurements were e at various locations. A large number of categories and sources of noise interference have been identified and a few fixes have been recommended.

Adjunct Professor Jauregui also continued work on position location hniques for high frequency signals. Previously collected data has been lyzed. Additional data has been collected on both shore and ship to test arization independent bearing techniques. Currently undergoing investi- ion are differential Doppler techniques at high frequency for course and ed.

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

The Research Program of the Electrical Engineering Department involves projects in the following areas: signal processing; electromagnetics, microwaves and antennas; communications; radar and electronic warfare; computer engineering; command, control, communications and intelligence (C^3I) systems; and electro-optics and fibre optics. Summaries of the current research projects follow.

SIGNAL PROCESSING

Professor Lonnie A. Wilson's project on automatic radar ship classification concentrated on the development of new target classification capabilities for cruise missile applications. Sensor improvements and processing systems have been initially developed for automatic target classification based on pattern recognition, artificial intelligence and advanced correlation techniques.

Professor John Powers initiated a project on propagation of pulsed ultrasound in lossless and tissue like media. A model has been formulated and has succeeded in explaining observed effects from experiments by other persons. Work continues on applying the technique to focused ultrasound and to layered media.

Professor Sydney Parker continued work on two projects. One on discrete time processing for modeling and filtering was directed toward the modeling of nonlinear systems. Results included identification of discrete Volterra kernels for nonlinear systems, exact computational schemes using modular arithmetic and the use of lattice parameter modeling for multidimensional fields. The second project concerns discrete signal processing and the research indicates that lattice parameters are an excellent set of criteria for fault identification in analog circuits. Ongoing work will include extension of the approach to artificial intelligence.

A project on elevated duct propagation prediction was initiated by Professor Jeffrey Knorr. The objective is to develop simple models and practical methods for predicting the power density of signals guided by elevated tropospheric ducts. A simple deterministic model has been developed and a study of the joint probability for elevated duct parameters has been completed.

ELECTROMAGNETICS AND MICROWAVES AND ANTENNAS

Professors Yi-Chi Shih and Kenneth Gray collaborated on examining the complex-power conversion technique for the study of bandpass filter structures in fin-lines. Two types of filters, the E-plane fin-line and the evanescent-mode waveguide dielectric-resonator, were designed. Preliminary designs were tested at x-band and k-band with good results.

Professor Knorr continued work on a millimeter wave network analyzer. A mathematical model of a scalar network analyzer has been developed using scattering parameters. A millimeter wave analyzer system has been constructed and experimentally observed behavior has been found to agree with that predicted by the model.

DEPARTMENT

OF

ELECTRICAL AND

COMPUTER ENGINEERING

Title: Range Studies Program

Investigators: O. B. Wilson, Professor of Physics; J. D. Esary, Professor of Operations Research

Sponsor: Naval Undersea Warfare Engineering Station

Objective: Conduct studies and research on problems related to long range research and development needs of the sponsor.

Summary: This is an ongoing program coordinated by the above named in investigators. Work on various tasks has been conducted by individual faculty and students in a number of different discipline areas and is reported separately by those individuals. Tasks areas include: torpedo track smoothing, Kalmann filter applications, fiber-optic data transmission applications, radio wave propagation studies, range tracking using acoustic surface interference, reliability studies.

Publication: O. B. Wilson, "Annual Summary Report - Range Studies Program. NPS Technical Report, NPS-61-84-001PR, October 1983.

Title: Studies of Shallow Water ASW Scenarios

Investigators: O. B. Wilson, Professor of Physics
Alan B. Coppens, Assoc. Professor of Physics
James N. Eagle, Assoc. Professor of Operations Research
Glenn H. Jung, Professor of Oceanography
James V. Sanders, Assoc. Professor of Physics

Sponsor: Naval Research Laboratory

Objective: Examine a number of scenarios relevant to shallow water ASW with the objective of identifying limitations of current systems and tactics in order to help guide directions for future environmental acoustic research in shallow water.

Summary:

F. Schwirzke, "Laser Induced Unipolar Arcing", Laser Interaction and Related Plasma Phenomena, Vol. 6, p. 335-352, Plenum Press, New York, 1983.

Conference Presentations:

F. Schwirzke, "Laser Induced Unipolar Arcing", Sixth International Workshop on Laser Interaction and Related Plasma Phenomena, Monterey, CA., October 1982

F. Schwirzke, "Unipolar Arcing, A Basic Laser Damage Mechanism", Fourteenth Annual Symposium on Optical Materials for High Power Lasers", National Bureau of Standards, Boulder, Colorado, November 1982

F. Schwirzke, W. F. Jenkins, and W. R. Schmidt, "Thermal Coupling and Damage Mechanisms of Laser Radiation on Selected Materials", 1983 IEE International Conference on Plasma Science, May 1983, San Diego, CA.

Thesis Directed:

W. F. Jenkins and W. R. Schmidt, "Thermal Coupling and Damage Mechanisms of 1.06 Micron Laser Radiation and Laser-Produced Plasma on Selected Materials", Master's Thesis, December 1982

Title: Short-Pulse Laser and Plasma Surface Interactions

Investigator: F. Schwirzke, Professor of Physics

Sponsor: Naval Research Laboratory

Objective: To use the short-pulse NRL Laser to investigate the time evolution of unipolar arcing, a basic laser damage mechanism.

Summary: Laser beams interact with target surfaces by a variety of thermal, impulse and electrical effects. Energy coupling is considerably enhanced once surface electrical breakdown occurs. The laser heated plasma interacts then with the surface via three major interrelated damage mechanisms: thermal evaporation, ion sputtering, and unipolar arcing. While the first two are purely thermal and mechanical effects, unipolar arcing is an electrical plasma-surface interaction process which leads to crater formation, usually called laser-pitting, a process which was often observed but not well understood. Without any external voltage applied, many electrical micro-arcs burn between the surface and the laser heated plasma, driven by local variations of the sheath potential with the surface acting as both the cathode and anode. Unipolar arcing represents the most damaging and non-uniform laser-plasma-surface interaction process since the energy available in the plasma concentrates towards the cathode spots. This causes cratering of the surface. Unipolar arcing is the primary plasma-surface interaction process once breakdown occurs. The onset of arc damage is coincident with the onset of plasma formation. Never was there a plasma evident without attendant unipolar arc craters. At low irradiance there was no other laser damage (like melting) observed, all damage was in the form of unipolar arc damage. The NRL neodymium laser with a pulse width of 5 ns was used to study unipolar arcing produced by short pulse laser radiation.

Publications: F. Schwirzke, "Unipolar Arcing, A Basic Laser Damage Mechanism", Naval Postgraduate School Report, NPS-61-83-008, 5 May 1983.

Title: Mean Flow and Turbulence in Complex Terrain

Investigators: G. E. Schacher, Professor of Physics
K. L. Davidson, Professor of Meteorology

Sponsors: Air Force Space Division and Army Atmosphric Science Laboratory

Objective: To gather mean flow and turbulence data in complex terrain so that the effect of terrain on diffusion can be modeled.

Summary: Data acquisition equipment has been constructed, programmed, and installed at Vandenberg AFB. The system obtains data from the permanent meteorological towers that exist at the base. Data is obtained from 94 sensors located on 11 towers. Horizontal wind speed and direction, air temperature, dew point temperature, visibility baromatric pressure, and short wave rdiation are sampled. Wind snesors are sampled every second, vector averged over 15 sec. periods, and all means and standard deviations recorded. The on-site data acquisiton and processing are operating satisfactorily. Quality assurance programs are being developed that will both check the data and perform statistical analyses.

Title: Gaussian Modeling for Overwater and Coastal Transport and Dispersion

Investigators: G. E. Schacher, Professor of Physics
K. L. Davidson, Professor of Meteorology

Sponsor: Office of Naval Research

Objective: To produce a one-hour average Gaussian model for the atmospheric transport of gasseous material in the overwater regime.

Summary: Diffusion models in current use have been developed for overland use and cannot be applied to the overwater case. NPS has available a large collection of data from overwater tracer experiments, which have been used to develop a one-hour average Gaussian model. The model is parameterized on wind spped, air-sea temperature difference, and relative humidity. These parameters are used to specify an overwater stability catagory, from which plume parameters are predicted. The overwater model has been completed and the results delivered to the Naval Enviornmental Reserch Prediction Facility. It is being incorporated in a threat assessment display model.

Title: Internal Explosions with Explosives Containing Reactive Metals

Investigators: Richard A. Reinhardt, Professor of Chemistry
Gilbert F. Kinney, Dist. Prof. Emeritus of Physics

Sponsors: Naval Weapons Center, China Lake and Naval Surface Weapons Center, White Oak

Objective: Continuation of research into the physicochemical behavior of confined explosions of reactive metals with fuels in air.

Summary: Calculations were performed for the temperature, pressure and product yield expected for the adiabatic internal explosion of a PBX material with aluminum in air. Calculations were begun for the related problems for magnesium plus aluminum in air. Satisfactory results were obtained for the equilibrium calculation in situations where oxygen was in excess.

Publications:

R. A. Reinhardt, "A Working Model for the System Alumina-Magnesia", Naval Weapons Center Technical Publication NWC TP 6433, May 1983

R. A. Reinhardt, "Computer Program for Internal Aluminum-Fuel-Air Explosions", Naval Weapons Center Technical Publication NWC TP 6449, August 1983

R. A. Reinhardt, "Internal Explosions of Reactive Aluminum with a PBX in Air", Naval Postgraduate School Project Report, NPS-61-83-011-PR, August 1983

Title:	Technical Support for NAVAIR IR&D
Investigator:	J. N. Neighbours, Professor of Physics
Sponsor:	Naval Air Systems Command
Objective:	To provide technical expertise in support of the Independent Research and Development (IR&D) program
Summary:	The principal investigator (PI) and other participating faculty members attend industry on-site IR&D reviews, visit NAVAIR-related industrial laboratories, and attend appropriate technical and scientific conferences. Reports on the results of these activities are submitted to AIR-30.

Title: Microwave Cerenkov Radiation

Investigator: J. R. Neighbours, Professor of Physics
F. R. Buskirk, Professor of Physics

Sponsor: NPS Foundation Research Program

Objective: To develop quantitative understanding of the microwave radiation from a periodic charged particle beam.

Summary: Microwave radiation in both X and K band has been detected when the NPS linac beam is allowed to propagate in air. This radiation has been identified as resulting from coherent Cerenkov radiation occuring as a result of collective radiation by each of the electron bunches in the linac beam. A theory of the effect has been developed and current research efforts are directed towards testing its range of validity. The radiated power as a function of frequency is of particular interest.

Publications: "Cerenkov Radiation from Bunched Electron Beams", by F. R. Buskirk and J. R. Neighbours, Naval Postgraduate School Report Number NPS-61-83-003 (October 1982)

"Diffraction Effects in Cerenkov Radiation", by J. R. Neighbours and F. R. Buskirk, Naval Postgraduate School Report Number NPS-61-83-010 (June 1983)

"Cerenkov Radiation from Periodic Electron Bunches", by F. R. Buskirk and J. R. Neighbours, Physical Review A. 28, 1531-1538, (Sept. 1983)

"Cerenkov Radiation from a Finite Gas Cell", by J. R. Neighbours, F. R. Buskirk, and A. Saglam, accepted for publication in Physical Review A.

Title: Measurement of the Effect of Turbulence on Airborne Optical Projectors.

Investigators: E. A. Milne, Associate Professor of Physics
G. W. Rodeback, Associate Professor of Physics

Sponsor: Pacific Missile Test Center

Objective: To make measurements of the optical turbulence in the atmosphere on a path between an airplane and a receiber on the ground.

Summary: Equipment developed in previous years was used to measure the optical turbulence on a path between an airplane and the gound. The results confirm that such measurments can be made on a live time basis. The sponsor is using the results of our measuremnts in analyzing the performance of equipment that they are testing.

Theses Directed:

B. A. Speer and F. H. Parker, "Measurements of Direct Path and Folded Path Optical Scintillation". Master's Thesis, December 1982.

R. J. Flenniken, "Weighting for the Modulation Transfer Function", Master's Thesis, June 1983.

A. G. Constantine, "Measurements of Direct Path and Folded Path Weightings", Master's Thesis, June 1983.

Professor Herschel Loomis has a continuing project on search algorithms and architectures for development of a signals intelligence (SIGINT) research facility. A small facility has been developed which will permit NPS students/faculty to engage in meaningful hands-on projects in the application of computer systems to search algorithms and to search modernization. Professor Loomis also continued work on a program on tactical information systems to develop hardware architectures and software techniques to support the delivery of timely, accurate tactical data. Techniques were developed for employing relational data bases as the key component in a sophisticated tracking and multi-source correlation system. Professor Loomis additionally continued work on design of high speed recursive digital filters using pipeline techniques and on computer aided design (CAD) of microprocessor based systems. A recursive filter design technique has been developed. A CAD design tool has been proposed. It has promise for cost-effective, rapid production of VLSI realizations of dedicated microprocessor systems.

Professors Rudolf Panholzer and Mitchell Cotton, with Professor Uno Kodres (COMPUTER SCIENCE), are continuing their involvement in sponsored AEGIS System research. They are involved in computer architectural research oriented to application of multiple microcomputers to real-time tactical data processing and weapons control.

Professors Donald Kirk and Robert Strum initiated a project on control systems and VLSI design studies. A control system design for sensitivity analysis of the Trident II thrust vector control system was realized and is being tested. VLSI design studies were concerned with making operational the CAD software obtained from DARPA VLSI contractors and using these tools to design a 16-bit pipelined adder for use in high speed digital filter structures. The design has been completed and verified.

COMMAND, CONTROL, COMMUNICATIONS AND INTELLIGENCE (C^3I) SYSTEMS

Professor Paul H. Moose and Kai E. Woehler (PHYSICS) continued their studies on Cybernetic Models of Military C^3I Systems. Five different two-species nonlinear evolution equations were analyzed and their dynamical properties determined. Four of the five are environmentally unstable. An experimental approach is now needed to determine what coupling mechanisms are at work before further analytical progress will be possible.

Professor Wilson continued work on a project on multi-source track management (MSTM). Electronic warfare (EW) sensors have been integrated in a Similar Source Processor. Several architectures have been investigated for the EW Similar Source Processor and such efforts will continue.

ELECTRO-OPTICS AND FIBER-OPTICS

Professor John P. Powers continuing project on fiber optics in underwater range applications has completed a technology survey and developed computer interconnects and underwater data links. Work continues in all these areas.

TITLE: Performance of Optimum and Suboptimum Incoherent Digital Communication Receivers in the Presence of Noise and Jamming

INVESTIGATORS: D. C. Bukofzer, Adjunct Professor of Electrical Engineering

SPONSOR: Naval Electronic Systems Command

OBJECTIVE: To determine jamming vulnerability of conventional digital communication receivers.

SUMMARY: Optimum jamming strategies were derived and analyzed and alternate jamming waveforms were investigated.

PUBLICATIONS: D. C. Bukofzer, "Performance of Optimum and Suboptimum Incoherent Digital Communication Receivers in the Presence of Noise and Jamming," IEEE Transactions on Aerospace and Electronic Systems, in progress.



Prof. S. Jauregui, Prof. W. R. Vincent, and
Lt. S. Levanduski are examining 2D and 3D displays
of signals in noise at high frequency.

TITLE: Noise and Interference at U.S. Navy HF Receiving Stations

INVESTIGATORS: Stephen Jauregui, Jr., Adjunct Professor of Electrical Engineering, W. R. Vincent, Adjunct Professor of Electrical Engineering

SPONSOR: Naval Electronics Systems Command

OBJECTIVE: To measure and categorize noise and interference at HF receiving stations. For noise and interference coming from nearby attempt to isolate sources and recommend fixes.

SUMMARY: This is an ongoing project attempting to improve the signal to noise ratio at HF receiving stations by identifying and reducing the noise at these sites. The measurement tools include a 3D display which allows discrimination of various categories of interference such as lightening burst, corona, ignition, ISM, parasitics, intermodulation products, etc. The noise and interference come from sources that are distant, nearby and self generated. Since only those sources that are nearby or generated within the system can be improved upon, the majority of the effort has been spent on collecting and identifying these classes of noise and interference. During FY83 measurements were made at Skaggs Island, California, Misawa, Japan, Winter Harbor, Maine, and Wahiawa, Hawaii. A large number of categories and sources of noise and interference have been identified and a few fixes have been recommended.

CONFERENCE PRESENTATION: S. Jauregui, "The Noise Part of Signal to Noise Ratio at HF," The Canukus Communications Conference, Ottawa, Canada, June 1983.

THESES DIRECTED: M. A. Carson, "Considerations for an All-Digital HFDF System," Master's Thesis, December 1982.

J. P. O'Neill, Jr., "Electromagnetic Interference in U.S. Naval Security Group Field Stations," Master's Thesis, June 1983.

TITLE: Position Location Techniques for High Frequency Signals

INVESTIGATOR: Stephen Jauregui, Jr., Adjunct Professor of Electrical Engineering

SPONSOR: Naval Electronics Systems Command

OBJECTIVE: To improve position location techniques for tactical and strategic purposes at the high frequencies.

SUMMARY: This is a continuing effort in the understanding and improving HF position location techniques. In the past most of the effort has been in the fix algorithm area and in analyzing shipboard line of bearing data. In addition HF skywave time differences of arrival data was collected in FY82 and was analyzed this fiscal year. Along with the analysis of HF TDOA data, further collection both ashore and aboard ship was accomplished in HF skywave signals to test polarization independent bearing techniques. Assistance was also given in the collection and analysis of single station location techniques using data collected by NRL in November 1982. Currently undergoing investigation are differential doppler techniques at HF for course and speed.

CONFERENCE PRESENTATION: S. Jauregui, "Trends in Operational HFDF," 28th Annual Joint EW Conference, Quantico, VA, May 1983.

THESES DIRECTED: O. E. Burns, III, "The Results of a TDOA Experiment," Master's Thesis, December 1982.

R. R. Groeller, "An Investigation of SSL Techniques," Master's Thesis, September 1983.

D. L. Carmichael, "Propagation Prediction; Application to HFDF," Master's Thesis, September 1983.

TITLE: Control Systems and VLSI Design Studies

INVESTIGATORS: Donald E. Kirk, Professor of Electrical Engineering, Robert D. Strum, Professor of Electrical Engineering

SPONSOR: Strategic Systems Project Office

OBJECTIVE:

1. To develop computer-aided control design techniques and investigate their application to Trident control systems.

2. To develop capability for custom design of LSI and VLSI integrated circuits for signal processing and test applications.

SUMMARY: The control systems design phase of the project was focused on a sensitivity analysis of the Trident II thrust vector control system. The robustness of the system to significant size parameter variations was investigated. The method of Stein and Doyle [1] was applied to improve system robustness. This resulted in improved stability margins, but did not help convergence of the nozzle displacement estimate in the presence of parameter variations.

The VLSI design studies concentrated on making operational the CAD software obtained from DARPA VLSI contractors, and on applying these tools to the design of a 16-bit pipelined adder for use in high speed digital filter structures. The design has been completed and verified using simulation programs for: (1) functional correctness; (2) satisfaction of design rules; and (3) timing. The design file has been forwarded to DARPA's silicon foundry for fabrication.

Reference

[1] J. C. Doyle and G. Stein, "Robustness with observers," IEEE Trans. Automatic Control Vol. 24 No. 4, August 1979.

THESES DIRECTED: John W. Geary, "Sensitivity Analysis of the Trident II Missile Thrust Vector Control System with Extendable Exit Cone," Master's Thesis, June 1983.

Joseph R. Conradi and Bruce R. Hauenstein, "VLSI Design of a 16 Bit Very Fast Pipelined Carry Look Ahead Adder," Master's Thesis, September 1983.



Prof. Jeffrey B. Knorr and Capt. John Deal discuss millimeter wave fin-line filter measurements.

TITLE: Elevated Duct Propagation Prediction

INVESTIGATOR: Jeffrey B. Knorr, Professor of Electrical Engineering

SPONSOR: Independent Research

OBJECTIVE: To develop simple models and practical methods for predicting the power density of signals guided by elevated tropospheric ducts.

SUMMARY: During the past year, improvements have been made to a simple deterministic model for predicting the power density of ducted signals. A study of the joint probability for elevated duct parameters has also been completed.

PUBLICATIONS: Knorr, J. B., "Simple Model for the Computation of Height-Gain in the Presence of Elevated Tropospheric Ducts," Technical Report NPS-62-82-045TR, September 1982.

THESIS DIRECTED: Robert Yelverton, "MINIDUCT: A Microcomputer Based Elevated Duct Circuit Code," Master's Thesis, September 1982.

David Petke, "A Numerical Investigation of the Power Distribution of Signals Propagated Through Elevated Tropospheric Ducts", Master's Thesis, September 1982.

D. Weston, "Predicting the Propagation Effects of Elevated Tropospheric Ducts: An Investigation of One Tactically Useful Model," Master's Thesis, March 1983.

W. Gavett, "Distribution of Probability in an Elevated Duct Sample Description Space," Master's Thesis, September 1983.



Prof. Chin-Hwa Lee and Cesar De Miranda demonstrate image processing.

TITLE: Computer Region Segmentation of Serial Photographs

INVESTIGATOR: Chin-Hwa Lee, Associate Professor of Electrical Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To collect experimental results of the recursive splitting with hierarchical scopic views segmentation algorithms.

SUMMARY: A recursive splitting method at hierarchical scopic levels has been implemented. The two main problems, the splitting criteria and the boundary discontinuity problems are studied. The proposed solution will be tested on the digital imagery sets. Additional experimental results are collected to substantiate the effectiveness of the solutions.

PUBLICATIONS: Chin-Hwa Lee, "Interpolation of Weighted-Average Samples Using Cubic B-Spline Function, Proceedings of IEEE Vol. 71 No. 4, April 1983.

Chin-Hwa Lee, "A Bus Monitoring Controller," Proceedings of Mini-Micro Computers and Their Applications, May 16-17, 1983.

CONFERENCE PRESENTATION: Chin-Hwa Lee, "A Bus Monitoring Controller," Mini-Micro Computer Conference, San Francisco, CA, May 16-17, 1983.

tle: Perturbative Model Analysis of the Back-Scattering Characteristics of a Missle over Several Frequency Bands

vestigator: Hung-Mou Lee, Assistant Professor of Electrical Engineering

onsor: NPS Foundation Research Program

jectives: (1) To develop an analytic theory on the scattering of electromagnet 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 of targets with increasingly complex shapes.

mmary: Analytic formulations to compute the surface current on a finite cylinder were derived. Computer codes were written and are being debugged in order to facilitate the evaluation of the analytical solutions over a 18:1 frequency range. This theory led to the identification of the modes of surface currents responsible for the resonances at different frequencies. An immediate application is to investigate the changes in resonance modes caused by a small change in the geometry of the cylinder. Experimental data to be accumulated in this study will help the identification of different targets. Acquisition of laboratory equipments was completed. They are being assembled so that automatic measurements of phase and magnitudes of back scattered waves can be performed.

blications: "Double series expansion of the Green's function for a perfectly conducting tubular cylinder of finite length." Radio Science 18(1), 48-56, January-February 1983.

nference Presentations: "Scattering current on a circular, tubular, perfectly conducting cylinder of finite length." Presented at the joint USNC/URSI Meeting and the IEEE International Symposium of AP-S in May 1983 at Houston, with the abstract published in the URSI Proceedings.

TITLE: Development of Search Algorithms and Architectures

INVESTIGATORS: H. H. Loomis, Jr., NAVELEX Chair Professor of Electrical Engineering, L. A. Cox, Assistant Professor of Computer Science

SPONSOR: Department of Defense

OBJECTIVE: To develop algorithms and architectures for the processing of signals in the furtherance of the NSA mission.

SUMMARY: Work in this general area has been concerned with the development of a SIGINT research facility and with the investigation of digital implementation of cyclic spectrum analysis techniques.

(1) Development of Search Algorithm Test-Bed.

A small computer controlled VLF-HF receiver and signal analysis system has been designed and constructed. The system incorporates a high-speed analog to digital converter and an add-on array processor supplied by another government agency. The design is expandable, and fully supports parallel processing by dissimilar devices. This system permits NPS students and faculty to engage in meaningful hands-on projects in the application of computer systems to search algorithms and to search modernization. The system is able to operate at the SI/SAO level, and is the only such facility available at that level at NPS.

(2) Cyclic Spectrum Analysis.

Prof. William Gardner (Electrical Engineering, University of California at Davis) has been working on the use of his theory of Cyclostationary processes in the detection and characterization of spread spectrum signals. His theoretical work has provided the framework for an ongoing research project at NPS [1]. We are currently completing research in the testing of a class of Cyclic Spectrum Analysis algorithms for application to Spread Spectrum detection and characterization [2]. Work is currently in progress to design high speed, low cost add-on processor architecture for the real-time evaluation of the cyclic spectrum.

PUBLICATION: [1] W. A. Gardner, "Detection of Spread-Spectrum Signals," Final Report on NPS Contract #N62271-83-M-0708, Davis, CA, September 1983.

CONFERENCE PRESENTATION: H. H. Loomis, Jr., W. A. Gardner, W. R. Tucker, Report on Project Salesclerk," NSA, W3, forthcoming.

THESIS DIRECTED: [2] William Tucker, "Digital Cyclic Spectral Analysis Techniques for the Detection and Identification of Signals in Noise," Master's Thesis, September 1983.

TITLE: Naval Electronics Systems Command Research Chair in Electrical Engineering

INVESTIGATOR: H. H. Loomis, Jr., NAVELEX Chair Professor of Electrical Engineering

SPONSOR: Navel Electronic Systems Command

OBJECTIVE: The objective of this project is to conduct research in two areas: 1) The design of high speed recursive digital filters using pipeline techniques and 2) the development of computer aided design techniques for microprocessor based systems.

SUMMARY: High-speed Digital Filters.

This research has developed a technique for the design of recursive filters using pipeline multiply and add modules and is producing designs for pipeline IC modules to best exploit these techniques for high-speed filter production. The research has resulted in a paper describing the idea [1], and a Ph.D. dissertation, as well as a pending patent application based on the original idea developed at the University of California.

Computer Aided Design of Microprocessor Based Systems.

A design tool has been proposed which will automatically generate the hardware and software necessary to realize dedicated microprocessor systems from a high level description of the problem and its timing constraints [2]. This system was originally implemented for the computer aided design of real-time controllers. This system has great promise for the cost-effective, rapid production of VLSI realizations of dedicated microprocessor based systems such as controllers or signal processors.

Recent research has been directed at the following areas:

(1) Application of the idea to Digital Filter realization.
(2) Development of techniques for the automatic production of library volumes using Hardware Descriptive Language (HDL) representations of the primative functions to be realized and available microprocessors and their support chips.
(3) Specific libraries representing the 8086 and Z-80 microprocessor families.

Title:	Dynamic Routing for Packet Radio
Investigator:	J. M. Wozencraft, Professor of Electrical Engineering
Sponsor:	Naval Ocean System Center
Objective:	To develop improved dynamic routing protocols for packet radio networks.
Summary:	A new protocol, using a shortest-distance algorithm due to J.H. Yen, was developed and demonstrated by computer simulation of a packet network.
Publications:	R.R. Logan, "Application of a Distributed Routing Algorithm to a Packet-Switched Communications Network", NPS Technical Report 62-83-060.
Conference Presentation:	Workshop on "Research Trends in Military Communications", Communications Sciences Institute, University of Southern California, 1-4 May 1983, Wickenburg AZ.
These Directed:	R. R. Logan, op cit., Master's Thesis, December 1983. H. T. Schiantarelli, "Multiple Path Static Routing Protocols for Packet Switched Networks", Master's Thesis, Sept 1983.

.E: Multi-Source Track Management

:STIGATOR: Lonnie A. Wilson, Associate Professor of Electrical Engineering

NSOR: Naval Sea Systems Command

ECTIVE: To provide theoretical analysis and system tradeoff analysis for the MSTM function of the ACDS. Automatic track management and multi-source identification (MSID) processing architectures and algorithms will be developed, analyzed, and evaluated.

MARY: The U.S. Navy has advanced combat direction systems (ACDS) requirements to fully develop sensor and C^3I assets for multi-source track management (MSTM). Current Navy systems have good automatic target detection and limited target tracking capabilities. New Navy ACDS systems should provide improved automatic MSTM with automatic multi-source classification, identification and track.

This past year efforts have been initiated to integrate Electronic Warfare Sensors and the ACDS systems. EW Sensors have been integrated in a Similar Source Processor. Several architectures have been investigated for the EW Similar Source Processor. These efforts will continue during the next fiscal year.

SES DIRECTED: E. Brady, "Integration of Shipboard ESM Sensors and Processing into ACDS," Electrical Engineer's Thesis, December 1982.

J. R. Gwyn, "Integration of AN/SLQ-32 Electronic Warfare System and the ACDS," Master's Thesis, September 1983.

Lonnie A. Wilson, "Range-Only Radar Ship Signatures - Ship No. 5 and Resolution No. 1," NPS Working Report, August 1983.

Lonnie A. Wilson, "Range-Only Radar Ship Signatures - Ship No. 5 and Resolution No. 3," NPS Working Report, August 1983.

Lonnie A. Wilson, "Range-Only Radar Ship Signatures - Ship No. 1 and Resolution No. 3," NPS Working Report, August 1983.

CONFERENCE PRESENTATIONS:

Lonnie A. Wilson, "Modulation Artifacts in a Multi-Emitter CW Environment," 16th Asilomar Conference on Circuits, Systems and Computers, Pacific Grove, CA, November 8-10, 1982.

Lonnie A. Wilson, "Shift and Scale Invariant Preprocessor," 16th Asilomar Conference on Circuits, Systems and Computers, Pacific Grove, CA, November 8-10, 1982.

Lonnie A. Wilson, "Theoretical UMOP Characteristics of Some RF Emitters," 28th Annual Joint Electronic Warfare Conference, May 1983 (CONFIDENTIAL).

THESES DIRECTED:

D. L. Arnold, "Classification of Ships Using Range Only Radar Profiles," Electrical Engineer's Thesis, December 1982.

S. Brunson, "Onboard Passive Ship Classifier for Cruise Missiles," Electrical Engineer's Thesis, December 1982.

R. Reese, "Tactical Anti-Ship Missile (TASM) ESM Processor Architecture," Master's Thesis, September 1983.

K. Williams, "Tactical Anti-Ship Missile (TASM) ESM Antenna/Receiver Configuration," Master's Thesis, September 1983.

ITLE: Automatic Ship Classification for Cruise Missiles

NVESTIGATOR: Lonnie A. Wilson, Associate Professor of Electrical Engineering

PONSOR: Joint Cruise Missiles Project Office

BJECTIVE: To develop automatic radar ship classification techniques and technologies for cruise missile applications.

UMMARY: The U.S. Navy has limited target classification capabilities for long stand-off range, all weather, multiple targets, and day/night applications. This project has concentrated on the development of new target classification capabilities for cruise missile applications. The radar and ESM sensors are being utilized as the signature information sources. Sensor improvements and processing systems have been initially developed for automatic target classification based on pattern recognition, artificial intelligence and advanced correlation techniques.

UBLICATIONS:

Lonnie A. Wilson and Paul J. Nahin, "Modulation Artifacts in a Multi-Emitter CW Environment," 16th Asilomar Conference on Circuits, Systems and Computers, November 1982.

Lonnie A. Wilson and Norman E. Huston, Jr., "Shift and Scale Invarient Preprocessor," 16th Asilomar Conference on Circuits, Systems, and Computers, November 1982.

Lonnie A. Wilson, James K. Crosby, and Donald Wehner, "Radar Imaging Technology," 1983 U.S. DoD Tri-Service Conference on Improved Weapons Performance via Combat Identification Systems (CISC-83) Proceedings, February 1983.

Lonnie A. Wilson, "Theoretical UMOP Characteristics of Some RF Emitters," 28th Annual Joint Electronic Warfare Conference Proceedings, May 1983.

Lonnie A. Wilson, "Range-Only Radar Ship Signatures - Ship No. 1 and Resolution No. 1," NPS Working Report, August 1983.

Lonnie A. Wilson, "Range-Only Radar Ship Signatures - Ship No. 4 and Resolution No. 3," NPS Working Report, August 1983.

Lonnie A. Wilson, "Range-Only Radar Ship Signatures - Ship No. 4 and Resolution No. 1," NPS Working Report, August 1983.

TITLE: Fin-Line Bandpass Filter Structures for Use at Microwave and Millimeter Wave Frequencies

INVESTIGATORS: Y. C. Shih, Adjunct Professor of Electrical Engineering, and K. G. Gray, Associate Professor of Electrical Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To analyze and design bandpass filter structures in finline for use at microwave and millimeter-wave frequencies.

SUMMARY: The complex-power conservation technique was studied and applied to analyze the discontinuities in filter structures. The resulting scattering parameters were then used in a synthesis technique based on a distributed half-wave step-impedance filter prototype. Two types of filters, the E-plane fin-line filter and the evanescent-mode waveguide dielectic-resonator filter, were designed. Some preliminary designs were tested at x-band and k-band with good results.

CONFERENCE PRESENTATION: Y. C. Shih and K. G. Gray, "Convergence of Numerical Solutions of Step-Type Waveguide Discontinuity Problems by Modal Analysis," 1983 IEEE-MTT-S Intl. Microwave Symposium, Boston, MA, May 3 - June 3, 1983.

THESIS DIRECTED: K. Alexander and S. Hamel, "Analysis and Design of Fin-Line Filters," Master's Thesis, September 1983.

S. R. Parker and Y. C. Lim, "On the Synthesis of Lattice Parameter Digital Filters," International Conference on Acoust. Speech and Signal Processing, April 1983, pp. 213-216.

S. R. Parker, "Efficient Positive Coefficient Algorithm for Image Processing," Electronic Letters, March 1983.

S. R. Parker and J. Thomas, "Modeling and Identification of Discrete Nonlinear Moric Average Systems by Means of Tensors," International Conference on Forecasting, June 1983.

THESES DIRECTED:

Kaptan, "Nonlinear Modeling of an Active Nonlinear Filter," Master's Thesis, December 1982.

Gialidis, "Design of Digital Filter Using Lattice Parameters," Master's Thesis, December 1982.

Fidan, "Quantization Noise in 2D Filters," Master's Thesis, December 1982.

TITLE: Discrete Time Processing for Modeling and Filtering

INVESTIGATOR: S. R. Parker, Professor of Electrical Engineering

SPONSOR: Office of Naval Research

OBJECTIVE: To investigate techniques for the discrete time modeling of linear and nonlinear circuits and systems.

SUMMARY: During the report period several areas of work have been directed towards the modeling of nonlinear systems with discrete mathematics using tensor operations. The results have included the identification of discrete Volterra kernals for nonlinear systems, exact computational schemes using modular arithmetic, and finally the use of lattice parameter modeling for multidimensional fields. The latter has wide applications to nonlinear systems, image processing, and image recognition (including voice prints) which are currently being explored.

PUBLICATIONS:

S. R. Parker, C. W. Therrien and R. B. Leonard, "Discrimination of a Set of Delay - Modulated Signals with Application to Radar Target Identification," Asilomar Conference on Circuits and Systems, November 1982, pp. 106-111.

S. R. Parker, "Filter Design Over a Discrete Power-of-Two Coefficient Space," IEEE International Conference on Circuits and Systems, May 1983.

S. R. Parker and Y. C. Lim, "Filter Design Over a Discrete Power-of-Two Coefficient Space," IEEE Trans. on Acoust. Speech and Signal Processing Vol. ASSP-31 No. 3, June 1983, pp. 583-591.

S. R. Parker, Y. C. Lim and A. H. Kayran, "A Discrimination Technique for Optimum Data Transfer in One and Two Dimensional FIR Digital Filters," International Symposium on Circuits and Systems, May 1983, pp. 1079-1082.

S. R. Parker and Y. C. Lim, "Efficient FIR Filter Implementation Using Microprocessors," International Conference on Acoust. Speech and Signal Processing, April 1983, pp. 443-446.

TITLE: Discrete Signal Processing

INVESTIGATOR: S. R. Parker, Professor of Electrical Engineering

SPONSOR: Naval Electronics Systems Command (via Naval Ocean Systems Command)

OBJECTIVE: To develop algorithms for the discrete time modeling on analog circuits and systems for fault analysis and identification.

SUMMARY: Work on this research indicates that lattice parameters are an excellent set of criteria for fault identification in analog circuits. The algorithms which have been developed have been tested with an actual circuit, rather than a computer simulation, including component tolerance effects with excellent results. These algorithms are now being studied and evaluated at NOSC. Present work includes extension of the approach to artificial intelligence in that the algorithm self adapts and learns the most efficient means to identify a fault.

THESES DIRECTED: Zivich, "Sequential Adaptive Multichannel Lattice Parameter Modeling," Master's Thesis, June 1983.

Powers, "A Comparison of Approaches to Multichannel Modeling," Master's Thesis, October 1982.

Dale W. Wittig, "Distributed Computation System for Measurement of Radar Target Signatures," Master's Thesis, December 1983.

Choong Y. Chong, "Investigation of Methods for Natural Resonance Radar Target Identification," Master's Thesis, December 1983.

TITLE: Measurement of Natural Resonance Parameters for Radar Target Identification

INVESTIGATOR: M. A. Morgan, Associate Professor of Electrical Engineering

SPONSOR: Office of Naval Research

OBJECTIVE: To advance the state of the art in experimental and theoretical techniques for radar target identification through the use of natural resonances extracted from scattered echo signatures.

SUMMARY: Theoretical and experimental work in the areas of target recognition and imaging via transient scattering responses has been an ongoing effort at the Naval Postgraduate School (NPS) for the past 4 years. This research was initially sponsored through the NPS Research Foundation Program and was first approached via direct target imaging. This continued effort, sponsored by ONR, utilizes natural resonances.

There are two primary aspects of this endeavor. The first of these is the continued improvement of a new computerized experimental scattering facility which uses a very short baseband impulse to illuminate targets of interest. This technique allows the synthesis of wide-band resonance region radar returns all based upon a single impulse response measurement from the target. Further digital signal processing is performed for the extraction of natural resonance parameters for use in target identification. The development of optimal signal processing algorithms for this purpose is the second primary goal of this work.

PUBLICATION: M. A. Morgan, "Singularity Expansion Representations of Fields and Currents in Transient Scattering," IEEE Transactions on Antennas and Propagation, forthcoming, May 1984.

CONFERENCE PRESENTATION: M. A. Morgan, "S-plane Representations for Transient Electromagnetic Scattering Signatures," National Radio Science Meeting, University of Houston, Houston, TX, May 23-26.

THESIS DIRECTED: Fernando M. C. Manilha, "Investigation of Methods for Natural Resonance Radar Target Identification," Master's Thesis, December 1982.

Manuel Mariategui, "Development of a Free-Field Transient Scattering Range," Master's Thesis, December 1983.

TITLE: Transient Scattering and Signal Processing

INVESTIGATOR: M. A. Morgan, Associate Professor of Electrical Engineering

SPONSOR: Defense Advanced Research Projects Agency

OBJECTIVE: Using transient electromagnetic scattering measurements from scale model radar targets the broadband PCS is evaluated for Rayleigh and Resonance region frequencies.

SUMMARY: This is a continuing investigation concerning the optimum synthesis of radar cross section (RCS) from transient measurements of scattering. Three particular tasks have received intensive consideration. There has been an in-depth study and measurements concerning s-plane RCS measurement not in the theoretical far-field. Secondly, there is a continuing theortical-experimental study regarding the physical SEM respresentation of target transient response in the early-time while under driver excitation and to consider the implications of this regarding signal processing strategies and s-plane representation of RCS. Finally, there has been development of an optimal theoretical technique for system deconvolution which will be used for scatterer impulse response synthesis.

CONFERENCE PRESENTATION: M. A. Morgan and M. L. Van Blaricum, "Considerations of Resonance Extraction from Transient Scattering Measurements," 1982 National Radio Science Meeting, Boulder, CO, January 1983.

THESIS DIRECTED: Fernando M. C. Manilha, "Investigation of Methods for Natural Resonance Radar Target Identification," Master's Thesis, December 1982.

Manuel Mariatequi, "Development of a Free-Field Transient Scattering Range," Master's Thesis, December 1983.

Dale W. Wittig, "Distributed Computation System for Measurement of Radar Target Signatures," Master's Thesis, December 1983.

Choong Y. Chong, "Investigation of Methods for Natural Resonance Radar Target Identification," Master's Thesis, December 1983.

TITLE: Cybernetic Models of Military C^3I

INVESTIGATORS: Paul H. Moose, Associate Professor of Electrical Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: Investigate the sensitivity of system stability to the basic assumptions regarding the mechanisms coupling counter-C^3 actions to intelligence information.

SUMMARY: Five different two-species non-linear evolution equations were analyzed. They model, respectively, (1) mixed attrition Lanchester combat with replenishment, (2) four different models of "information war". Their dynamical properties were determined, and it has been shown that four of the five are environmentally unstable. The meaning of this for, C^3I and counter-C^3 is that until the basic mechanisms of information war are ascertained, it is impossible to predict whether deception and other counter-C^3 measures are fundamentally stabilizing or destablizing factors in modern warfare. An experimental approach is now needed to determine what coupling mechanisms are in fact at work before further analytical progress will be possible.

PUBLICATION: P. H. Moose, "Evolution Equations of C^3I: Cononical Forms and Their Properties," NPS-62-83-059, October 1983, A135293.

TITLE: Research and Development of Computer Architectures for End User Tactical Data Analysis.

INVESTIGATORS: H. H. Loomis, Jr., NAVELEX Chair Professor of Electrical Engineering, L. A. Cox, Assistant Professor of Computer Science

SPONSOR: Naval Electronic Systems Command

OBJECTIVE: To develop hardware architectures and software techniques to support the delivery of timely, accurate tactical data derived from off-board sensors to the tactical commander.

SUMMARY: Computer Architectures and Algorithms for Tactical Information.

Research in this area has concentrated on end-user tactical information systems and the issues of computer architecture and algorithms as they relate to such systems. Two NPS thesis students have developed techniques for employing relational data bases as the key component in a sophisticated tracking and multi-source correlation system. Also under this project as well as project SALESCLERK, a SCI secure computing facility has been developed to permit application of the results of this research to real problems.

THESES DIRECTED: Raymond F. Bernstein, Jr., "Ocean Surveillance Analysis Using a Relational Data Base System(U)," Master's Thesis, December 1982.

John S. Witherspoon, "A Relational Data Base Application in Tracking and Correlation(U)," Master's Thesis, June 1983.

PUBLICATIONS:

[1] H. H. Loomis, Jr. and B. Sinha, "High Speed Realization of Recursive Digital Filters," International Journal of Circuits, Systems and Signal Processing, forthcoming.

[2] Alan A. Ross, Herschel H. Loomis, Jr. and George G. Pollock, "Real Time Systems: An Approach to Computer Aided Design of Hardware and Software," Proceedings, Twentieth Allerton Conference on Communication, Control, and Computing, Monticello, IL, October 1982.

CONFERENCE PRESENTATION:

Alan A. Ross, Herschel H. Loomis, Jr. and George G. Pollock, "Real Time Systems: An Approach to Computer Aided Design of Hardware and Software," Twentieth Allerton Conference on Communication, Control, and Computing, Monticello, IL, October 1982.

THESIS DIRECTED:

M. Heilstedt, "Automated Design of Microprocessor-based Digital Filters, Master's Thesis, June 1983.

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

INVESTIGATOR: L. J. Ziomek, Assistant Professor of Electrical 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: Wave propagation in a random, inhomogeneous ocean was treated as transmission through a linear, time-variant, space-variant, random communication channel. A consistent notation (vis-a-vis ad hoc), fundamental input-output relations, and various time-space transformations for both deterministic and random linear, time-variant, space-variant, filters were established. Using the method of separation of variables and the WKB approximation, a time-invariant, space variant, random transfer function of the ocean volume was derived. The ocean volume was characterized by a random index of refraction which was a function of depth. The index of refraction was decomposed into a deterministic component and a zero mean random component. In addition, two example calculations were made. 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.

PUBLICATION: L. J. Ziomek, "Linear Time-Variant Space-Variant Filters and the WKB Approximation," NPS Technical Report, forthcoming.

CONFERENCE PRESENTATION:

L. J. Ziomek, "Undersea Acoustic Propagation in a Random Ocean - A Linear Systems Theory Approach," 1983 DARPA Undersea Surveillance Symposium, Monterey, CA, 18-22 July 1983.

DEPARTMENT

OF

METEOROLOGY

DEPARTMENT OF METEOROLOGY

The research program in the Department of Meteorology continues in several areas: (1) numerical air and ocean modeling and prediction, (2) analysis and dynamics of tropical weather systems, (3) marine atmospheric boundary layer studies, (4) marine area prediction using model output statistics, (5) regional weather studies and (6) satellite remote sensing. Under each of these headings, a number of related investigations have been pursued by various faculty members.

NUMERICAL MODELING AND PREDICTION

R. T. Williams is developing and testing numerical procedures for global and regional weather prediction. He is investigating various finite element formulations with respect to treatment of small-scale flow fields. He will apply the techniques to the prediction of air flow near mountains, and to tropical cyclones. R. T. Williams and M. A. Rennick are studying topographic effects and the behavior of planetary waves with a spectral baroclinic model. L. C. Chou, R. T. Williams and C.-P. Chang are investigating the "Mei-Yu" rains in China with a moist frontal model.

R. L. Elsberry and R. W. Garwood, Jr. (Oceanography) have used a one-dimensional mixed-layer model to predict the upper ocean response to atmospheric forcing on time scales ranging from diurnal to seasonal changes. In a joint effort with R. L. Haney, the mixed-layer model has been embedded into an oceanic general circulation model. This new model will now be used in a variety of oceanic investigations including the response of the ocean to tropical and extratropical storms (R. L. Elsberry) and the dynamics of large scale low frequency variability in the North Pacific Ocean (R. L. Haney).

A combined diagnostic-prognostic approach is being used by R. L. Elsberry, C. H. Wash and C.-S. Liou to study maritime extratropical cyclones. The atmospheric model being implemented at the Fleet Numerical Oceanography Center has been used to study the role of air-sea fluxes in extratropical cyclogenesis. Diagnostic studies of the numerically-predicted fields are being made for comparison with similar studies using real data.

Other modeling efforts include (1) a dynamical-statistical model for predicting the movement of tropical cyclones, led by R. L. Elsberry, (2) a marine atmospheric boundary layer model for predicting (6-18 hours) properties which affect radar and optical propagation within the boundary layer and those factors (radiation and boundary fluxes) which affect the upper part of the ocean, directed by K. L. Davidson, and (4) a study on the impact and methods of coupling an ocean mixed-layer model to an atmospheric prediction system (R. L. Elsberry and C.-S. Liou).

ANALYSIS AND DYNAMICS OF TROPICAL WEATHER SYSTEMS

C.-P. Chang, R. L. Elsberry and R. T. Williams continue to investigate various aspects of the dynamics of tropical weather systems, including development of hurricanes and typhoons by R. L. Elsberry, the dynamics of tropical synoptic and planetary scale waves and lateral interactions by C.-P. Chang and R. T. Williams, and the diagnostic analysis of winter and summer monsoon circulations by C.-P. Chang. C.-P. Chang and J. S. Boyle also studied the interannual variations of tropical circulations using a ten-year global data base. M. A. Rennick, R. L. Haney and C.-P. Chang are investigating mechanisms of large-scale air-sea interaction in the tropics using coupled numerical models. The work concentrates on ocean temperature and atmospheric circulation anomalies associated with El Niño.

MARINE ATMOSPHERIC BOUNDARY LAYER STUDIES

Research in this area includes several interdisciplinary shipboard/aircraft observational and theoretical projects involving K. L. Davidson and W. J. Shaw. Objectives of the individual projects are: (1) to evaluate and formulate models which relate changes in the depth and structure of the atmospheric mixed layer (capped by an inversion) to surface fluxes and sky conditions, (2) to evaluate and formulate models for equilibrium marine aerosol distributions, (3) to establish synoptic-scale descriptions of the magnitude and height variations of optical turbulence, (4) to relate near-surface aerosol distributions to whitecap coverage, (5) to determine dispersion properties of the atmospheric boundary layer in the California coastal region and (6) to evaluate synoptic-scale forcing on the boundary processes and evolutions utilizing data from single (in situ) stations. Long range objectives of this work are to provide tactical assessment and predictive procedures for electromagnetic, optical and dispersion properties of the marine boundary layer. W. J. Shaw has begun a measurement effort involving acoustic remote sensing which will relate the overall structure and evolution of the boundary layer to the small-scale structure of turbulence.

MARINE AREA PREDICTION USING MODEL OUTPUT STATISTICS

A new multiple-year project directed toward applying the methods of model output statistics (MOS) to forecasting operationally important air and ocean parameters to 48-h, for all oceans of the world, was begun in FY 1983. The research, involving R. J. Renard and R. W. Preisendorfer, is initially concerned with forecasting surface horizontal visibility (predictand) over the North Atlantic Ocean area. Predictor information is being derived from the Navy's Operational Global Atmospheric Prediction System (NOGAPS). Development of an appropriate MOS approach is underway, with a decision on the particular method due in FY 84. Under consideration and testing are maximum-probability and natural regression strategies, formulated by R. W. Preisendorfer, as well as the more standard linear regression and discriminant analysis approaches.

REGIONAL WEATHER STUDIES

Pressure, temperature and vector wind data from the Antarctic remote-site automatic weather stations on/near the Ross Ice Shelf area, and surface and upper-air observations at McMurdo, Antarctica are being analyzed by R. J. Renard and associates for their contribution to regional climatology and improved operational weather forecasting. Forecasting visibility and wind at the surface have been emphasized in FY 1983.

R. J. Renard, F. R. Williams and G. H. Jung (Oceanography) continued efforts at developing a weather forecasting digest for the Southern African Continent and the surrounding South Atlantic and Indian Ocean areas. The digest will concentrate on synoptic- and mesoscale atmospheric circulations of importance to forecasting for air and sea operations in the area.

SATELLITE REMOTE SENSING

K. L. Davidson was involved with observational studies concerned with surface truth evaluations derived from satellite-borne scatterometer estimates of the oceanic surface-layer wind and satellite-borne microwave radiometer estimates of the sea-surface temperature. Furthermore, aerosol distribution data obtained off the California coast are being used to assess the role of atmospheric extinction of 'grey shade' patterns within usual satellite imagery (DMSP). C. H. Wash is applying interactive computer techniques to GOES and NOAA visual, infrared and other radiometric data to specify cloud and precipitation patterns using the NEPRF Satellite Processing and Acquisition System.

Title: Interactions of Synoptic and Interannual Variations of Large-Scale Motions during Winter

Investigators: C.-P. Chang, Professor of Meteorology, J. S. Boyle, Adjunct Professor of Meteorology and K. M. Lau, Visiting Scientist

Sponsor: National Oceanic and Atmospheric Administration

Objective: To study the interannual variations of the large-scale flow over the Asia-Pacific region and their interaction with the synoptic time scales.

Summary: A ten-year atlas on the seasonal anomalies of tropical streamfunction, velocity potential and outgoing long wave radiation is under preparation. These data were used to study the Pacific-North America teleconnection pattern associated with El Nino-Southern Oscillation. Preliminary results showed that in individual events of anomalies, the teleconnection and tropical heating may not be in phase or necessarily closely related. The satellite data also revealed that the tropical ocean-atmosphere system contains a large-scale oscillation between two seemingly-stable climate states which manifest itself spatially as a fluctuating dipole pattern.

Publications:

K. M. Lau and P. H. Chan, "Short-Term Climate Variability and Atmospheric Teleconnection from Satellite Outgoing Longwave Radiation. I: Simultaneous Relationships." Journal of Atmospheric Sciences (forthcoming).

K. M. Lau and P. H. Chan, "Short-Term Climate Variability and Atmospheric Teleconnection from Satellite Outgoing Longwave Radiation. II: Lagged Correlations." Journal of Atmospheric Sciences (forthcoming).

K. M. Lau, C.-P. Chang and P. H. Chan, "Short-Term Planetary-Scale Interactions over the Tropics and Midlatitudes during Northern Winter. Part II: Winter MONEX Period", Monthly Weather Review, 111, July 1983, 1372-1388.

Conference

C.-P. Chang, "Short Term Midlatitude-Tropical Interactions during Winter Monsoon", WMO Regional Conference on Tropical Meteorology, Tsukuba, Japan, October 18-22, 1982, Extended Abstracts, World Meteorological Meteorology, 129-130.

K. M. Lau and P. H. Chan, "Low-Frequency Variability of the Tropical Circulation as Inferred from Satellite Radiation Data," WMO Regional Conference on Tropical Meteorology, Tsukuba, Japan, October 18-22, 1982, Extended Abstracted, World Meteorological Meteorology, 155-156.

Title: Tropical and Monsoon Studies

Investigators: C.-P. Chang, Professor of Meteorology and
R. T. Williams, Professor of Meteorology

Sponsor: National Science Foundation

Objective: To study the structure and dynamics of large-scale flow in the tropics and other areas which are influenced by monsoons. This is a continuing project.

Summary: On the observational study of winter monsoon it was found that the East Asia cold surges exert an influence to the tropical convection even when it is located in the equatorial central Pacific, and that the effects of the enhanced midlatitude baroclinicity cause a downstream teleconnection which influences the synoptic developments over the west coast of the U.S. On the theoretical study of planetary scale motions forced by tropical heating, two types of atmospheric response were studied by an eigenmode analysis on an equatorial beta-plane. The first type is the less rotationally trapped "barotropic" motions which show some of the characteristics of the teleconnection patterns from tropics to midlatitudes. The second type is the more rotationally trapped, warm-core, deep baroclinic motions which resemble the Walker circulations. The analysis reveals several important inadequacies in previous modeling studies, and provides a relatively comprehensive explanation of the dynamics of both types of disturbances of the Rossby and Kelvin modes. In particular the Rossby mode is found to be more important than the Kelvin mode in the Walker circulations. Furthermore, the westerly mean wind solution points out the importance of the transient nature of the forcing. Studies on other tropical systems, including the upper level easterly jet and Southeast Asia convective systems were also being continued.

Publications: C.-P. Chang, J. E. Millard and G. T. Chen, "Gravitational Character of Cold Surges during Winter MONEX", Monthly Weather Review, 111, February 1983, 293-307.

K. M. Lau, C.-P. Chang and P. H. Chan, "Short-Term Planetary-Scale Interactions over the Tropics and Midlatitude during Northern Winter. Part II: Winter MONEX Period", Monthly Weather Review, 111, July 1983, 1372-1388.

K. R. Saha and C.-P. Chang, "The Baroclinic Processes of Monsoon Depressions", Monthly Weather Review, 111, July 1983, 1506-1514.

H. Lim and C.-P. Chang, "Dynamics of Teleconnections and Walker Circulations Forced by Equatorial Heating", Journal of Atmospheric Sciences, 40, August 1983, 1897-1915.

R. T. Williams, H. Lim and C.-P. Chang, "Nonlinear and Linear Effects in an Easterly Jet with Downstream Variation", Journal of Atmospheric Sciences (forthcoming).

G. T. Chen, E. Gerish and C.-P. Chang, "Structure and Variations of the Synoptic-Scale Cyclone Disturbances near Borneo during the WMONEX Period", Monthly Weather Review (submitted).

K. M. Lau, and H. Lim, "On the Dynamics of Equatorial Forcing of Climate Teleconnections", Journal of Atmospheric Sciences (forthcoming).

Conference Presentations:

C.-P. Chang, "Short Term Midlatitude-Tropical Interactions during Winter Monsoon", WMO Regional Conference on Tropical Meteorology, Tsukuba, Japan, October 18-22, 1982, Extended Abstracts, World Meteorological Meteorology, 129-130.

C.-P. Chang, "A Review of Midlatitude-Tropical Interactions over East Asia during Cold Surges", AIT-CCNAA Joint Seminar on Monsoon and Tropical Meteorology, Taipei, Taiwan, April 17-22, 1983, Proceedings, 59-65.

C.-P. Chang, "Large-Scale Effects of Cold Surges", U.S.-PRC Workshop on Monsoon Research, Beijung, China, July 3-14, 1983.

L. C. Chou, C.-P. Chang and R. T. Williams, "Numerical Simulation of the Mei-Yu Front", WMO Regional Conference on Tropical Meteorology, Tsukuba, Japan, October 18-22, 1982, Extended

Abstracts, World Meteorological Meteorology, 147-148.

H. Lim, C.-P. Chang and K. M. Lau, "A Theory on Globa- Responses to Equatorial Forcing", WMO Regional Conference on Tropical Meteorology, Tsukuba, Japan, October 18-22, 1982, Extended Abstracts, World Meteorological Meteorology, 143-144.

Thesis Directed: B. J. Baker, "Numerical Simulation of the Forcing of Monsoon Surges by Mid-Latitude Baroclinic Waves", Master's Thesis, September 1983.

Title: Atmospheric Forcing on Ocean-Atmospheric Mixed Layer Processes

Investigators: K. L. Davidson, Professor of Meteorology and G. E. Schacher, Professor of Physics

Sponsor: Office of Naval Research

Objective: Couple micro-computer coded models for the ocean (OBL) and atmosphere (ABL) well mixed boundary layers and evaluate joint responses in each layer on basis of predicted radiation and kinetic energy transfer.

Summary: Separate ABL (Davidson et al, 1984) and OBL (Garwood) micro-computer scaled models have been coded so they can be run simultaneously on micro (HP 9838 and HP 9845) and large frame (IBM 3033) computers. The primary outcome of the coupled model prediction has been in the ocean regime wherein the radiation heating has a definite effect. The model has been tested on both clear and cloudy sky cases. A difference in the ABL evolution between coupled and uncoupled prediction occurs when the Liflung condensation level is slightly above the mixed layer and a 2 meter OBL mixed layer with ΔT of .8 occurs. This work led to support in FY 84 for observational experiment off California coast (MILDEX).

Publications:

K. L. Davidson, P. J. Boyle and G. Geernaert, "Wind Wave Coupling Effects on the Atmospheric Boundary Layer during STREX," Journal of Geophysical Research (1984), forthcoming.

K. L. Davidson and R. W. Garwood, "Coupled Atmosphere and Oceanic Boundary Layer Model," Dynamics of Oceans and Atmosphere (1984), forthcoming.

Theses Directed:

M. O'Loughlin, "Coupled Ocean Atmospheric Boundary Layer Prediction Model," Master's Thesis, Dec 1982.

G. L. Tarbet, "Formulation of Micro-computer Coupled Atmosphere Ocean Mixed Layer Model," Master's Thesis, Dec 1983.

R. D. Bisking, "Further Development and Examination of the Marine Atmospheric Boundary Layer Model (MABL)," Master's Thesis, Sep 1984.

:le: Marine Boundary Layer Modeling for the Aerosol Contribution to Optical Extinction

'estigator: K. L. Davidson, Professor of Meteorology and
G. E. Schacher, Professor of Physics

)nsor: Naval Air Systems Command

jective: Validate a model to predict in the marine atmospheric boundary layer and make measurements which characterize its optical properties.

mmary: Tasks in Fy 83 involved model verification and collection of data in areas not involved in its empirical formulation. The data used in verification were from CEWCOM-78, JASIN and MAGAT. Papers listed below describe these results. The MAGAT data is the remaining set to be competed. It is being used in an MS thesis (Saunders) effort. Aerosol data collection using from a ship (R/V Polarbjorn) in the Marginal Ice Zone of the East Greenland Sea, MIZEX-83. The experiment was for 6 weeks 15 June - 30 July. Low visibility (fog) was the general condition during the entire 6 weeks. Data analysis is now being condicted. These measurements will be made again in the same region in June and July 1984.

)lications: C. W. Fairall, K. L. Davidson and G. E. Schacher, "An Analysis of the Surface Production of Sea Salt Aerosol," Tellus, 35B (1983), 31-39.

K. L. Davidson and L. Schutz, "Observational Results on the Influence of Surface Layer Stability and Inversion Entrainment on Surface Layer Marine Aerosol Number Density (1 m)," Optical Engineering, 22 (1983) 45-49.

E. C. Monahan, C. W. Fairall, K. L. Davidson and P. A. Jones, "Observed Inter-Relationships amongst 10 m Elevation Winds, Oceanic Whitecaps and Marine Aerosol," QJRMS, forthcoming.

C. W. Fairall, "Total Optical Depth and Mixed Layer Visibility in the Marine Regime," Optical Engineering, 22 (1983), 50-56.

C. W. Fairall and S. E. Larsen, "Dry Deposition, Surface Production and Dynamics of Aerosols in the Marine Boundary Layer," Atmospheric Environment, forthcoming.

Theses Directed:

R. Graves, "Tactical Applications of an Atmospheric Mixed Layer Model," Master's Thesis, Dec 1982.

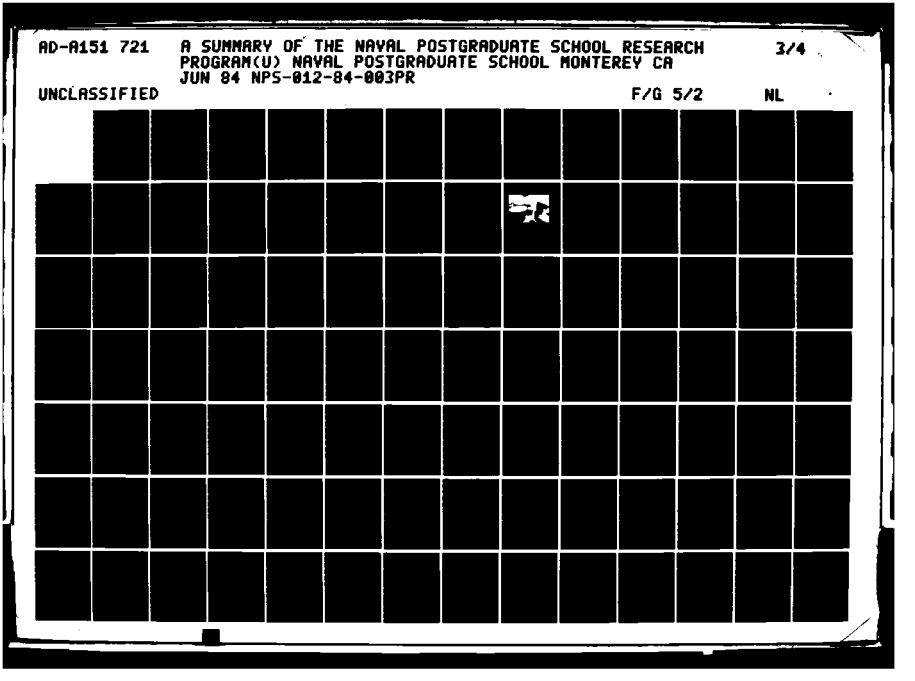
M. O'Loughlin, "Coupled Ocean Atmospheric Boundary Layer Prediction Model," Master's Thesis, Dec 1982.

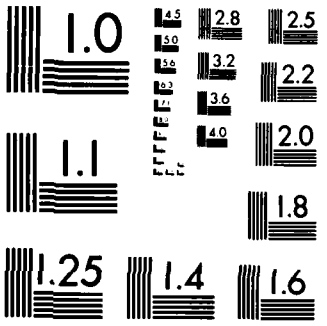
G. L. Tarbet, "Formulation of Micro-computer Coupled Atmosphere Ocean Mixed Layer Model," Master's Thesis, Dec 1983.

R. B. Wilkerson, "Predictability of Inversion at Vandenberg AFB, CA," Master's Thesis, Mar 1984.

AD-A151 721 A SUMMARY OF THE NAVAL POSTGRADUATE SCHOOL RESEARCH PROGRAM(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA JUN 84 NPS-012-84-003PR 3/4

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Title: Optical Turbulence in the Marine Boundary Layer

Investigator: K. L. Davidson, Professor of Meteorology, and
G. E. Schacher, Professor of Physics

Sponsor: High Energy Laser Program Office (PMO 405

Objective: Relate surface layer optical turbulence (C_N^2) to seasonal and geographic synoptic meteorological regimes and evaluate Wyngaard-Lemone inversions.

Summary: Mean and median C_N^2 values were related to synoptic scale features on an approach which used to describe EM wave propagation (Refractive Effects Guidebook). Observed surface layer wind, temperature and humidity values and surface temperatures were used in bulk aerodynamic expression to estimate C_N^2. Data used were from experiments conducted by NPS personnel. Airborne data during MAGAT, Gulf of Mexico and White Sands Missile Range experiments have been evaluated relative to the Wyngaard-Lemone inversion scaling procedures.

Publications:

C. W. Fairall, "Factors Relating Surface Visibility to the Total Optical Depth in the Marine Regime," Technical Report NPS 63-82-004CR (1982), 29 pp.

C. W. Fairall, "An Analysis of the Wyngaard-Lemone Model of Refractive Index and Micrometeorological Structure Functions at the Top of a Turbulent Mixed Layer," Technical Report NPS 63-82-006CR (1982), 101 pp.

C. W. Fairall, "Total Optical Depth and Mixed-Layer Visibility in the Marine Regime," Optical Engineering, 22, 50-56.

P. J. Boyle and K. L. Davidson, "Synoptic Classification and Horizontal Homogeneity of the Refractive Index Structure Function Parameter in the Surface," (1984), 53 pp.

C. W. Fairall, K. L. Davidson and G. E. Schacher, "Applications of a Mixed Layer Model to Aerosols in the Marine Boundary Layer," Tellus (1983), forthcoming.

K. L. Davidson and C. W. Fairall, "Dynamics and Modeling of Aerosols in the Marine Atmospheric Boundary Layer," Proceedings, Whitecap Workshop, University College, Galway, Ireland, Sep 1983, forthcoming.

Thesis Directed: D. J. Saunders, "Evaluation of Aerosol Prediction Model for Coastal Region," Master's Thesis, Mar 1984.

Title: Observational Studies of Marine Boundary Layer Processes

Investigators: K. L. Davidson, Professor of Meteorology and G. E. Schacher, Professor of Physics

Sponsor: Naval Air Systems Command

Objective: Characterization prediction of the evolution of boundary layer over ocean and ice regions.

Summary: This research program consists of a boundary layer model development and an experimental field program. The modeling effort is based on the empirical relation of entrainment at the top of the layer ot the surface fluxes. The intention is to allow prediction of boundary layer evolution from routine shipboard radiosonde and future surface layer winds. The model includes the effects of subsidence and radiation. The experimental effort is directed toward characterizing the boundary layer structure and turbulence properties under different stability, cloud cover and surface roughness conditions. In June and July 1983 surface layer measurements were made from an ice breaker (R/V Polarbjorn) in the East Greenland Sea Marginal Ice Zone (MIZEX). These measurements were part of the two year Marginal Ice Zone Experiment (MIZEX). The 1983 program is viewed as a pilot. The measurements will be made from two ships in June and July 1984.

Publications:

K. L. Davidson and L. Schutz, "Observational Results on the Influence of Surface Layer Stability and Inversion Engrainment on Surface Layer Marine Aerosol Number Density (1 m), Optical Engineering, 22, (1983), 45-49.

C. W. Fairall, K. L. Davidson and G. E. Schacher, "Applications of a Mixed Layer Model to Aerosols in the Marine Boundary Layer," Tellus, forthcoming.

K. L. Davidson, P. J. Boyle and G. E. Schacher, "Verification of an Atmospheric Mixed Layer Model for a Coastal Region," Journal of Climate and Applied Meteorology, forthcoming.

C. W. Fairall and S. E. Larsen, "Inertial Dissipation Methods and Turbulent Fluxes at the Air-Ocean Interface," Boundary Layer Meteorology, forthcoming.

Title: Relating Marine Aerosol Distribution to Oceanic Whitecaps

Investigator: K. L. Davidson, Professor, Department of Meteorology, and G. E. Schacher, Professor, Department of Physics

Sponsor: Office of Naval Research

Objective: To determine aerosol production per unit whitecap coverage on the basis of laboratory measurements and to relate open ocean aerosol data and whitecap coverage.

Summary: Analyses have been performed on data obtained in June 1980 and June of 1981 over laboratory generated whitecaps at University College Galway. Preliminary estimates were obtained of the produced aerosol size distributions as a function whitecap coverage. Aerosol size distributions obtained during the JASIN (North Atlantic) experiment in 1978 have been interpreted relative to aerosol flux spectra and whitecap coverage. Another experiment was held at UCG in September 1983. This was quite successful since the sampling volume was controlled and height variations addressed.

Publications:

E. C. Monahan, K. L. Davidson and D. E. Spiel, "Whitecap Aerosol PRoductivity Deduced from Simulation Tank Measurements," Journal of Geophysical Research, 87, (1982), 8898-8904.

E. C. Monahan, C. W. Fairall, K. L. Davidson and P. A. Jones, "Observed Inter-Relationships amongs 10 m-Elevation Winds, Oceanic Whitecaps and Marine Aerosol," QJRMS, forthcoming.

E. C. Monahan, D. E. Spiel and K. L. Davidson, "Model of Marine Aerosol Generation via Whitecaps and Wave Disruption," Proceedings, 9th AMS Conference on Aerospace and Aeronautical Meteorology, 6-9 June 1983, Omaha, NE, 174-152.

C. W. Fairall, K. L. Davidson and G. E. Schacher, "An Analysis of the Surface Production of Sea Salt Aerosol," Tellus, 35B, (1983) 31-39.

K. L. Davidson and C. W. Fairall, "Dynamics and Modeling of Aerosols in the Marine Atmospheric Boundary Layer," Proceedings, Whitecap Workshop, University College, Gallway, Ireland, September 1983, forthcoming.

Title: Review of the Mizex Experiment

Investigator: K. L. Davidson, Professor, Department of Meteorology

Sponsor: Naval Environmental Prediction Research Facility

Objective: Pay costs for honororarium for participants in MIZEX-83 Workshop. September 1983, held at Naval Postgraduate School.

Summary: Participants in the marginal Ice Zone Experiment (MIZEX) of the East Greenland Sea attended a workshop at NPS to discuss cooperative data analyses efforts. Honorarium were paid to three non-US government employees to assist in expenses incurred.

Title: Modeling Upper Ocean Thermal Structure

Investigators: R. L. Elsberry, Professor of Meteorology; R. W. Garwood, Jr., Associate Professor of Oceanography; P. C. Gallacher, Adjunct Research Instructor, Department of Meteorology, and A. A. Bird, Oceanographer, Department of Oceanography

Sponsor: Office of Naval Research

Objective: The long range scientific objective of this research is to understand the role of the oceanic planetary boundary layer (OPBL) in the distribution of energy, momentum and mass in the upper ocean in response to atmospheric forcing.

Summary: Mathematical models of entrainment and ocean mixing are developed and verified by comparison of numerical simulations with oceanic observations for such processes as the unsteady response of the mixed layer to changing atmospheric forcing and the response of upper ocean density fronts to local atmospheric forcing. Other processes involving application of turbulence closure modeling include: i) an investigation of the role of planetary rotation upon entrainment in deep mixed layers; ii) the use of nutrient data as a chemical tracer of mixed layer dynamics; iii) the nature and importance of coupling and feedback between the OPBL and the marine atmospheric boundary layer (MABL); and iv) the effect of interior motion on the generation of sea surface temperature anomalies

Publications: R. W. Garwood, L. K. Coachman, "Entrainment of tracers by the surface mixed layer," EOS, vol. 63, no. 45, p. 980.

P. Muller and R. W. Garwood, "Interaction between mixed layer and interior," EOS, vol. 63, no. 45, p. 1006.

Conference Presentations: R. W. Garwood, L. K. Coachman, "Entrainment of tracers by the surface mixed layer," Annual Meeting of the American Geophysical Union, San Francisco, December 7, 1983.

P. C. Gallacher, "Rotation stress in turbulent planetary boundary layers: Implications for equatorial mixed layers," XVIII General Assembly of the International Union of Geodesy and Geophysics, Hamburg, West Germany, August 1983.

P. Muller and R. W. Garwood, "Interaction between mixed layer and interior," Annual Meeting of the American Geophysical Union, San Francisco, December 10, 1983.

P. Muller and R. W. Garwood, "The effect of interior motions on sea surface temperature, mixed layer depth, and structure of the seasonal thermocline," XVIII General Assembly of the International Union of Geodesy and Geophysics (IAPSO), Hamburg, West Germany, August 1983.

K. Davidson and R. W. Garwood, "Coupled oceanic and atmospheric mixed layer model," XVIII General Assembly of the International Union of Geodesy and Geophysics, Hamburg, West Germany, August 1983.

Theses Directed:

J. J. Hall, "On the unsteady response of an oceanic front to local atmospheric forcing," Master's Thesis, June 1983.

D. G. Markham, "Ocean mixing and circulation response in the marginal ice zone," Master's Thesis, June 1983.

Title: Modeling Upper Ocean Thermal Structure

Investigators: R. L. Elsberry, Professor of Meteorology; R. W. Garwood, Jr., Associate Professor of Oceanography; P. C. Gallacher, Adjunct Research Instructor, Department of Meteorology, and A. A. Bird, Oceanographer, Department of Oceanography

Sponsor: Naval Ocean Research and Development Activity

Objective: Application of a one-dimensional oceanic boundary layer model for prediction of the upper ocean thermal structure.

Summary: As part of the ongoing effort to improve the prediction of upper ocean thermal structure features that may have an important impact on environmental support of fleet operations, the following activities have been performed this year: I) Values have been determined for the closure constants of the Garwood one-dimensional turbulence model of the upper ocean. These values optimize the constants for predicting changes in the thermal structure of the central North Pacific Ocean using surface forcing derived from the FNOC atmospheric prediction system. II) As part of the evaluation of these constants, statistical tests were developed and tested which quantify the forecast skill with this model. III) The model has been used to predict the thermal structure for a number of cases during the fall. Earlier, predictions of the generation and development of upper ocean thermal anomalies had been accomplished in the form of case studies for both spring-summer and winter-spring periods.

Publications: P. C. Gallacher, R. L. Elsberry, R. W. Garwood and A. A. Bird, 1982: "A mixed layer model simulation of the three-dimensional upper ocean temperature field in the central North Pacific," in "Progress Report on Numerical Experimentation," Joint Scientific Committee for the World Climate Research Program and the Global Atmospheric Research Program, Working Group on Numerical Experimentation, World Meteorological Organization, pp. 8.12-8.15.

P. C. Gallacher, R. L. Elsberry, R. W. Garwood and A. A. Bird, "A determination of the constants for a second order closure turbulence model from geophysical data," NPS Technical Report, #63-83-004, 1982.

R. W. Garwood, Jr. and D. Adamec, "Model simulations of seventeen years of mixed layer evolution at ocean station Papa," NPS Technical Report, #68-82-006, 1982.

R. L. Elsberry, "A synoptic case study analysis of the ocean temperature anomalies in the central Pacific region during 1976-79," NPS Technical Report, #63-83-00, forthcoming.

Conference Presentations:

P. C. Gallacher, R. L. Elsberry, R. W. Garwood and A. A. Bird, "Simulation of the three-dimensional upper ocean temperature field in the central North Pacific using a mixed layer model," Trans. of Amer. Geophys. Union, 63, Fall AGU meeting, 1982.

R. L. Elsberry, "Processes leading to large-scale mid-latitude Pacific Ocean anomalies," 18th General Assembly of International Union of Geodesy and Geophysics, Hamburg, Germany, August 15-27, 1983.

Title: Observational-Numerical Study of Maritime Extratropical Cyclones Using FGGE Data

Investigators: Russell L. Elsberry, Professor of Meteorology and Carlyle H. Wash, Assistant Professor of Meteorology

Sponsor: National Aeronautical and Space Administration

Objective: The objective of the proposed research is to better understand the development, maturation and decay of maritime extratropical cyclones using a combined observational and numerical modeling approach. The research will use FGGE Level III-b analyses for diagnostic studies and for predictions. A better understanding of maritime cyclogenesis via diagnostic studies of observed and numerical data will contribute to the GARP objectives of improving models for weather prediction and increasing predictability over oceanic regions.

Summary: Observational studies of three explosive cyclones have been completed using FGGE analysis; a coastal case, a polar low and an open-ocean case. Studies of diagnostic processes using the UCLA physics package have been initiated.

Publication: F. J. Winninghoff and R. L. Elsberry, "Some Aspects of Post-frontal Convective Areas off the West Coast of the United States." Technical Report, Naval Postgraduate School, Monterey, CA, 1983 (forthcoming).

Theses Directed: LT Wynn Calland, "Quasi-Lagrangian Diagnostics Applied to an Extratropical Explosive Cyclogenesis in the North Pacific," Master's Thesis, June 1983.

LT William Cook, "Quasi-Lagrangian Diagnostic Investigation of Rapid Cyclogenesis in a Polar Air Stream," Master's Thesis, September 1983.

Title: Oceanic Thermal Response to Atmospheric Forcing

Investigator: R. L. Elsberry, Professor of Meteorology

Sponsor: Office of Naval Research, Ocean Sciences Division

Objective: Understand and predict those changes in near-surface oceanic variables that are related to atmospheric forcing, especially on diurnal and synoptic time scales.

Summary: Oceanographic and meteorological observations and numerical simulations are used to understand the role of atmospheric forcing of the upper ocean layers. Estimates have been made of the errors in ocean thermal structure predictions at Ocean Weather Ship P due to incomplete or inaccurate initial data, and due to inaccurate atmospheric forcing (Elsberry, 1983; Elsberry and Adamec, 1983; Adamec and Elsberry, 1983). Oceanic response to mid-latitude and equatorial atmospheric forcing has been demonstrated with Garwood's ocean model (Elsberry, Sandgathe and Winninghoff, 1983a, 1983b).

Publications:

D. Adamec, and R. L. Elsberry, "Sensitivity of mixed layer predictions at ocean station Papa to atmospheric forcing parameters." Submitted to Journal of Physical Oceanography, 1983.

R. L. Elsberry, S. A. Sandgathe and Francis J. Winninghoff, "Short-term oceanic response predicted by a mixed layer model forced with a global sector atmospheric model." Journal Physical Oceanography, 1983a (forthcoming).

R. L. Elsberry, and D. Adamec, "Sensitivity studies with an upper ocean prediction model." Proc. of Workshop on the Predictability of Fluid Motions, American Institute of Physics, 1983 (forthcoming).

Conference

R. L. Elsberry, "Atmospheric forcing requirements for upper ocean thermal structure prediction." ONR Workshop on Air-Sea Interaction, Boulder, CO, 14-16 Feb 1983, 1983.

R. L. Elsberry, S. A. Sandgathe and F. J. Winninghoff, "Short-term oceanic response predicted by a mixed layer model forced with a global sector atmospheric model." International Union of Geodesy and Geophysics, Hamburg, Germany, August 1983, 1983b.

Title: Numerical Modeling of Large Scale Ocean Variability

Investigator: Robert L. Haney, Professor of Meteorology

Sponsor: Office of Naval Research

Objective: To study mechanisms for large scale variability in the North Pacific Ocean by means of controlled numerical model experiments.

Summary: A multi-level primitive equation ocean circulation model with surface layer physics has been used to study the interannual variability of sea surface temperatures (SST) and the subsurface thermal structure in the central North Pacific Ocean. Results from a ten-year model hindcast using observed winds are being analyzed and compared with observations. An analysis of model generated SST anomalies in comparison with observations suggests that observed SST anomalies in middle and lower latitudes are primarily wind driven. An analysis of the subsurface thermal variability in terms of Rossby waves is in progress and encouraging preliminary results have already been obtained. In a recent comment I have pointed out that an observed association between air temperatures over the U.S. and ocean temperatures in the midlatitude North Pacific are due to teleconnections from the equatorial region.

Publications:

R. L. Haney, B. H. Houtman and W. H. Little, "The Relationship between Wind and Sea Surface Temperature Anomalies in the Midlatitude North Pacific Ocean," Atmosphere-Ocean, 21(2), 168-186, 1983.

R. L. Haney, and J.C.L. Chan, "On the 1982/83 Warm Event in the Equatorial Pacific," Ocean Modelling, 52, 1-2, September 1983.

R. L. Haney, and N. D. Gural, "A Time Series of Model Hindcast Ocean Currents," CCCO Newsletter, forthcoming.

R. L. Haney, Comment on "Seasonality in the Associations between Surface Temperatures over the United States and the North Pacific Ocean," Monthly Weather Review, forthcoming.

DEFENSE

RESOURCES MANAGEMENT

EDUCATION CENTER

Title: Numerical Modeling of Unique Atmospheric Phenomena

Investigators: R. T. Williams, Professor of Meteorology and M. A. Rennick, Adjunct Assistant Professor

Sponsor: Naval Environmental Prediction Research Facility

Objective: To develop and test better procedures for use in Navy weather forecasting models.

Summary: Lee cyclogenesis was studied numerically with a numerical model which was recently developed by Prof. A. Arakawa of UCLA. Comparisons were made with a finite difference model which is very similar to the NOGAPS model which is in use at the Fleet Oceanographic Prediction Center and the spectral model which was developed by Dr. T. Rosmond of the Naval Environmental Prediction Research Facility. The tropopause problem with mountains was examined with a linearized spectral model and two methods of handling the problem were tested.

Conference Presentations:

J. L. Hayes, R. T. Williams and M. A. Rennick, "Numerical Studies of Atmospheric Lee Cyclogenesis", Fourth Conference on Atmospheric and Oceanic Waves and Stability of the American Meteorological Society, Boston, March 22-25, 1983.

M. A. Rennick and R. T. Williams, "Representation of the Tropopause Using Sigma Coordinates", Sixth Conference on Numerical Weather Prediction of the American Meteorological Society, Omaha, June 6-9, 1983.

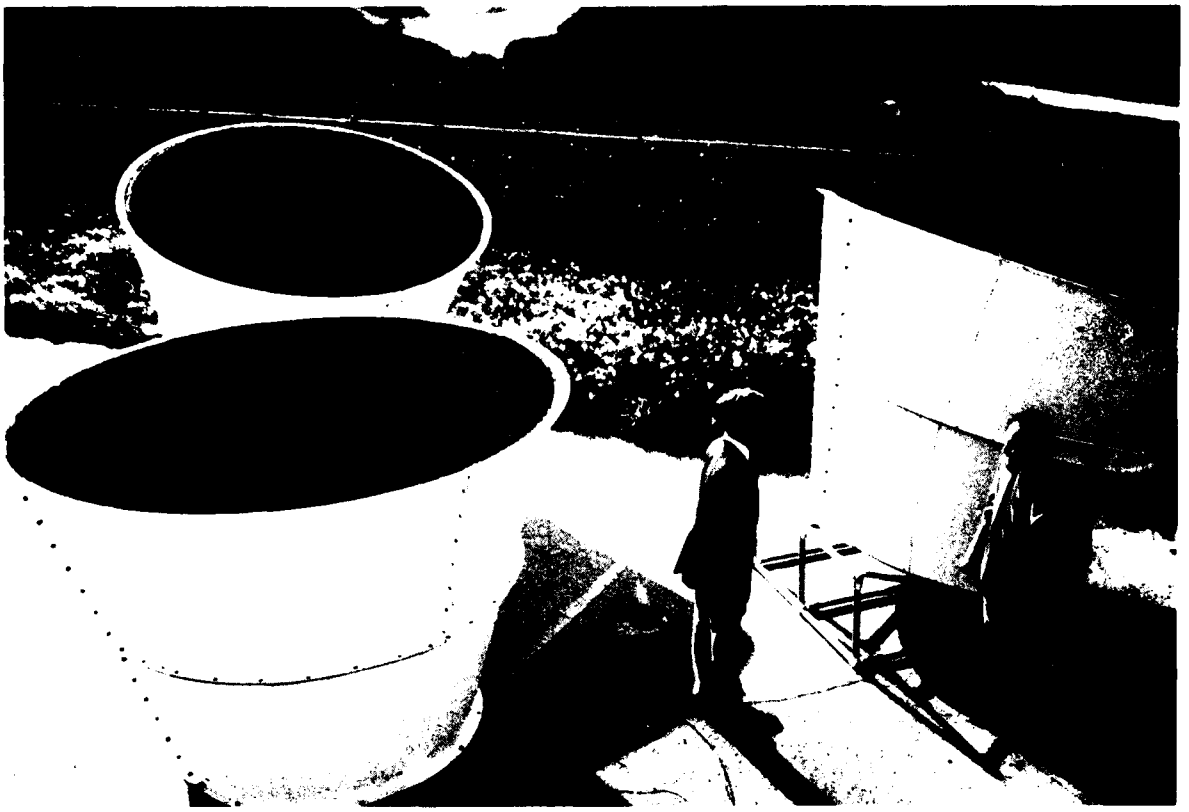
J. L. Hayes and R. T. Williams, "Numerical Simulation of Lee Cyclogenesis", Sixth Conference on Numerical Weather Prediction of the American Meteorological Society, Omaha, June 6-9, 1983.

Thesis Directed: J. P. Walker, "Numerical Simulation of the Influence of Small Scale Mountain Ranges on a Baroclinic Wave", Master's Thesis, December 1982.

Title:	Development of Finite Element Prediction Model
Investigators:	R. T. Williams, Professor of Meteorology, A. L. Schoenstadt, Associate Professor of Mathematics, and R. E. Newton, Professor of Mechanical Engineering
Sponsor:	Naval Air Systems Command
Objective:	To develop and test a finite element atmospheric prediction model.
Summary:	Various elliptic solvers were compared for possible use in a regional finite element model. The shallow water finite element model was tested with forcing, and shown to be superior to a comparable finite difference model.
Thesis Directed:	D. E. Hinsman, "Numerical Simulation of Atmospheric Flow on Variable Grids Using the Galerkin Finite Element Method", Doctoral Thesis, March 1983.

Title:	Quantitative GOES Satellite Data Analysis using SATDAT Processing and Display System (SPADS)
Investigator:	C. H. Wash, Assistant Professor of Meteorology
Sponsor:	Naval Air Systems Command
Objective:	Implement algorithms to analyze GOES visual, infrared and other channel data to produce specification of hazardous surface weather for naval operations (presence of precipitation, precipitation intensity, low visibilities and ceilings) in silent areas between conventional observations using the SPADS system.
Summary:	Cloud and precipitation estimation program was completed (Nelson, 1982) and is currently under evaluation using GOES data over the eastern coast of United States. Collocated GOES and surface data sets are being used to further develop cloud mapping techniques.
Thesis Directed:	LT Cynthia Nelson, "Estimation and Mapping of Cloud and Rainfall Areas with an Interactive Computer," Master's Thesis, December 1982.

Title:	Analysis of Aircraft Measurements of the Atmospheric Boundary Layer (ABL)
Investigator:	W. J. Shaw, Postdoctoral Associate, Department of Meteorology
Sponsor:	Naval Postgraduate School Foundation
Objective:	Extension of analysis of JASIN Experiment aircraft data.
Summary:	The research effort consisted of further examination of the properties and coherence of plume-like structures in the near-neutral marine boundary layer using the JASIN data base to generate cross-correlation functions derived from energy dissipation time series.
Publications:	W. J. Shaw and J. A. Businger, "Intermittency and the organization of turbulence in the near-neutral marine atmospheric boundary layer," (To be submitted to Journal of the Atmospheric Sciences), in progress.
Conference Presentations:	W. J. Shaw, "Intermittency and the Organization of Turbulence in the Near-neutral Marine Atmospheric Boundary Layer," American Meteorological Society Sixth Symposium on Turbulence and Diffusion, Boston, MA, March 22-25, 1983.



Prof. W. J. Shaw discusses the operation of the three-axis doppler SODAR with Lt. J. A. McNitt. SODAR (Sound Detection And Ranging) is used in probing the turbulence structure of the atmospheric boundary layer.

Title: Regional Synoptic Forecasting: Southern Africa

Investigators: R. J. Renard, Principal Investigator, Professor and Chairman, Department of Meteorology, and G. H. Jung, Professor, Department of Oceanography

Sponsor: Naval Air Systems Command

Objective: To assess the status of and make improvements on the analysis and forecasting of weather parameters important to air/sea operations over the Southern African Continent and surrounding South Atlantic/ Indian Ocean areas (approximately 5°N-45°S, 60°E-0°).

Summary: A weather forecaster's digest appropriate for use by the Navy's Operational Geophysical Officer and his staff is being developed. An outline of the Southern Africa weather forecaster's digest was devised and three major sections have been composed. These are the general introduction (i.e., boundaries, topography and general climatology of seven land and three ocean climatic zones), and the climatology of operationally important parameters along with their synoptic causes for two major areas, namely land area covered by South Africa, Namibia, Botswana, the South Angolan Coast and Malagasy, and the subtropical Indian Ocean area from the continent to 0° long, south to 30°S. In addition, a section of oceanographic aspects of the regional weather events is nearing completion. Two workshops on climatology and forecasting for the subject area were held in FY 1983. Completion of the digest is expected in FY 1984.

Publications: R. J. Renard, F. R. Williams, G. H. Jung and R. D. Tomkins, "Forecaster's Digest for the Southern African Continent and Surrounding Oceans," NEPRF Technical Report, in progress.

Thesis Directed: R. D. Tomkins, "Significant Weather Systems over the Southern African Continent and Surrounding Oceans" (R. J. Renard, advisor), Master's Thesis, in progress.

R. J. Renard and W. J. Thompson, "Use of Remote Site Automatic Weather Station Data for Analysis and Forecasting in the Western Ross Sea/Ice Shelf Area," International Union of Geodesy and Geophysics (IUGG), XVIII General Assembly, Hamburg, Federal Republic of Germany, 15-27 Aug 1983.

Theses Directed:

S. P. Hervey, "A Study of Antarctic Remote-Site Automatic Weather Station Data (1980-81), Master's Thesis (R. J. Renard, advisor), in progress.

C. G. Souders, "Forecasting Low Visibility Due to Blowing Snow/Fog in the Vicinity of McMurdo, Antarctica," Master's Thesis (R. J. Renard, advisor), in progress.

Title: Operational Weather Forecasting -- Antarctica

Investigator: R. J. Renard, Professor and Chairman, Department of Meteorology

Sponsor: Naval Support Force Antarctica

Objective: To improve the operational weather forecasting capability in Antarctica, with emphasis on the area surrounding the Naval Support Force Antarctica base at McMurdo.

Summary: In FY 1983, development of an updated climatology of low visibility at McMurdo and Williams Field, Antarctica due to blowing snow and fog, and substratified by various related parameters (e.g., wind, temperature, dew point, time of day), is underway. Automatic Weather Station (AWS) data from the western Ross Ice Shelf area continue to be collected and have been used to further develop climatological fields of wind, temperature and pressure in the area. A study of 1980-81 AWS data from the Ross Ice Shelf area is near completion. First drafts of statistical correlations (with and without lag) of events at the AWS and McMurdo have been developed for use in forecasting weather at McMurdo as a function of AWS's weather events.

Publications: R. J. Renard, W. J. Thompson and S. P. Hervey, "Analysis of Pressure, Temperature and Wind Data from Remote Site Automatic Weather Stations near McMurdo, Antarctica" in Proceedings of the First International Conference on Southern Hemisphere Meteorology, American Meteorological Society, Boston, MA, 1983, pp 234-37.

Conference Presentations: R. J. Renard, "Use of AWS Data in Weather Forecasting Vicinity of McMurdo, Antarctica," NSF Antarctic Automatic Weather Station (AWS) Conference, University of Wisconsin, Madison, WI, 6-8 Apr 83.

R. J. Renard, W. J. Thompson and S. P. Hervey, "Analysis of Pressure, Temperature and Wind Data from Remote Site Automatic Weather Stations near McMurdo, Antarctica," American Meteorological Society First International Conference on Southern Hemisphere Meteorology, Sao Jose dos Campos, Brazil, 31 Jul - 6 Aug 1983.

R. J. Renard and W. J. Thompson, "Use of Remote Site Automatic Weather Station Data for Analysis and Forecasting in the Western Ross Sea/Ice Shelf Area," International Union of Geodesy and Geophysics (IUGG), XVIII General Assembly, Hamburg, Federal Republic of Germany, 15-27 Aug 1983.

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R. J. Renard, W. J. Thompson and S. P. Hervey, "Analysis of Pressure, Temperature and Wind Data from Remote Site Automatic Weather Stations near McMurdo, Antarctica," American Meteorological Society First International Conference on Southern Hemisphere Meteorology, Sao Jose dos Campos, Brazil, 31 Jul - 6 Aug 1983.

Thesis Directed: M. L. Karl, "Development of a Model Output Statistics Scheme to Forecast Horizontal Visibility with Application to North Atlantic Ocean Area, Master's Thesis (R. J. Renard, advisor), in progress.

Title: Marine Area Prediction Using Model Output Statistics

Investigators: R. J. Renard, Principal Investigator, Professor and Chairman, Department of Meteorology; R. W. Preisendorfer, Research Chair Professor; and W. J. Thompson, Meteorologist, Department of Meteorology

Sponsor: Naval Air Systems Command

Objective: Using selected methods of model output statistics, develop prediction schemes to forecast (out to 48 hr) air/ocean parameters of operational importance to U.S. Navy activities over the open ocean and coastal waters.

Summary: A new multiple-year project directed toward applying the methods of model output statistics (MOS) to forecasting operationally important air and ocean parameters to 48-h, for all oceans of the world, was begun in FY 1983. The research, involving R. J. Renard and R. W. Preisendorfer, is initially concerned with forecasting surface horizontal visibility (predictand) over the North Atlantic Ocean area, which will be stratified into physically homogeneous areas to maximize forecasting skill. Predictor information is being derived using a basic set of 56 output parameters from the Fleet Numerical Oceanography Center's Operational Global Atmospheric Prediction System (NOGAPS). The potential predictability and prediction skill of each of the model output predictors will be considered. Prediction strategies under consideration and testing are maximum-probability and natural regression, formulated by R. W. Preisendorfer, as well as the more standard linear regression and discriminant analysis approaches. Development of an MOS approach appropriate to prediction at sea is underway with a decision on the particular method due in FY 1984.

Publications: R. J. Renard and W. J. Thompson, "Estimating Visibility over the North Pacific Ocean Using Model Output Statistics," National Weather Digest, Forthcoming 1984.

M. C. Koziara, R. J. Renard and W. J. Thompson, "Estimating Marine Fog Probability Using a Model Output Statistics Scheme," Monthly Weather Review, Vol. 112, No. 1, Forthcoming, 1984.

CONFERENCE PRESENTATIONS:

R. L. Haney, "A Ten-year Hindcast of the Central North Pacific Ocean. Fall Meeting of the American Geophysical Union, San Francisco, Dec 7-13, 1982.

R. L. Haney, "Predictability of Large Scale Sea Surface Temperature Anomalies from Atmospheric Wind Forcing," Workshop on Predictability of Fluid Motions, La Jolla, Feb 1-3, 1983.

R. L. Haney, "A Ten-year Hindcast of Large-Scale Sea Surface Temperature Anomalies in the Midlatitude North Pacific Ocean," XVIII General Assembly of the International Association for the Physical Sciences of the Ocean, Hamburg, Aug 15-27, 1983.

THESIS DIRECTED:

N. D. Gural, "Spectrum Analysis of Inertial and Subinertial Motions Based on Analyzed Winds and Wind Driven Currents from a Primitive Equation General Circulation Model," Master's Thesis, December 1982.

A. H. Rutsch, "Baroclinic Rossby Wave Signature in a General Circulation Ocean Model," Master's Thesis, June 1983.

DEFENSE RESOURCES MANAGEMENT EDUCATION CENTER

An active research program is encouraged at the Defense Resources Management Education Center (DRMEC), a tenant activity of the Naval Postgraduate School. The Center is staffed by civilian professors of the Naval Postgraduate School and by active duty military officers from all services.

The research program is designed to support the mission of DRMEC which is to conduct resource management education under the primary functional coordination and sponsorship of the Assistant Secretary of Defense (Comptroller), the Assistant Secretary of Defense (Manpower, Installations, and Logistics), The Director of Program Analysis and Evaluation, and the Assistant Secretary of Defense (International Security Affairs). The research of the faculty is diverse and reflects the broad academic content of the resource management programs at the Center.

Recently, the Center's research has focused on the following topic areas: infrastructure investment, the effects of defense spending in less developed economies, incentives in public purchase decisions, an approach to systemic budgeting, a comparative analysis of usage of CETS personnel, manpower assignment models, enlisted skill changes in the AVF, multiobjective decision techniques, organization behavior and decision making, quantity and quality effects of authorized dealer warrant maintenance agreements, and the impact of prices changes on aggregate output.

TITLE: Efficiency in Military Enlisted Occupational Assignment Systems

INVESTIGATOR: J. S. Blandin, Associate Professor

SPONSOR: None

OBJECTIVE: To develop and test a performance based model that would enhance the cost effectiveness of military enlisted occupational assignment systems.

SUMMARY: A multivariate model was developed to predict assignment success/failure. Success was defined in terms of an individual completing the initial enlistment term, and achieving E-4, and being recommended for reenlistment. Failure was defined as failing to complete an enlistment or not being recommended for reenlistment. Based on success in previous research and availability, 19 predictor variables were investigated. The model was estimated using enlistment/assignment data for the Aviation Structural Mechanic (AM) rating for those entering in 1976, 1977, and validated on the 1978 group. The results indicate that 1) improvements in the Navy's initial assignment of individuals to the AM rating could be made, and 2) the Navy already is extremely successful in assigning personnel who transfer to the AM rating. It was roughly estimated that savings of between 7 million to 39 million dollars for 1976-1977 would have been possible if the model had been available and used.

THESIS DIRECTED: R. D. Whitmire and C. G. Deitchman, "An Enlisted Performance Prediction Model for Aviation Structural Mechanics," Master's Thesis, September 1983. (Co-Advisor with Professor R. S. Elster.

TITLE:	The Manpower Force Mix: Changes in Service Enlisted Technical Skills
INVESTIGATOR:	J. S. Blandin, Associate Professor, and J. H. Morris, Associate Professor.
SPONSOR:	None
OBJECTIVE:	To examine the degree of structural shift in the enlisted technical skill (MOS) mix for the U.S. Army from 1974-1981.
SUMMARY:	The study shows that a clear shift has occurred in the MOS structure for the U.S. Army over the 74-81 time period. As a percentage of the enlisted force structure, this shift has been toward MOS's in the mid to high category of technical complexity and away from those in the lower category. The enlisted force structure also changed with respect to quality as measured by AFQT and level of education over the same period. However, these changes were in somewhat the opposite direction from what was predicted. From 1974-1981, the percentage of Category I/II individuals fell in both the mid to high categories of technical MOS complexity. With respect to education, the percentage of enlistees with some college fell by almost 50% over the period while the percentage of high school graduates increased.
CONFERENCE PRESENTATION:	J. S. Blandin and J. H. Morris, "The Manpower Force Mix: Changes in Service Enlisted Technical Skills," ORSA/TIMS 1982 Joint National Meeting, San Diego, October 25-27, 1982.

TITLE: Comparative Analysis of Usage of CETS Personnel

INVESTIGATOR: Robert E. Boynton, Associate Professor, DRMEC

SPONSOR: OP 124

OBJECTIVE: To examine various aspects of Navy policy and practice which influence the requirement for CETS personnel. Investigation focuses on training, resource availability, and manning levels.

SUMMARY: Background research and initial data collection began in late FY 83. No results are available at this time.

TITLE:	Systemic Budgeting
INVESTIGATOR:	J. E. Dawson, Professor of Public Budgeting, DRMEC
SPONSOR:	Rand Corporation and the Office of the Assistant Secretary of Defense, Comptroller
OBJECTIVE:	To develop new taxonomies and analytic capabilities for use in the understanding of and conduct of public budgeting.
SUMMARY:	Systemic budgeting considers the public budget and the economy as one system. It emphasizes the total public budget -- federal, state, and local. It extends the time horizon to include changes in capital stocks, public and private, and changes in demographic characteristics of the people. The current focus is on the issue of resources to be available for defense through the mid 1990s.
CONFERENCES:	None to date
PUBLICATIONS:	J. E. Dawson, "A Model for Systemic Budgeting," A Rand Report to be published in early 1984.

TITLE: The Effect of Various Types of Road Investment Infrastructure Projects on Economic Growth in the Philippines.

INVESTIGATORS: P. C. Frederiksen, Associate Professor of Economics, DRMEC, and R. E. Looney, Associate Professor of Economics, NSA.

SPONSOR: None

OBJECTIVE: To investigate whether different types of infrastructure have different effects on economic growth in developing countries.

SUMMARY: The results confirmed that paved road density was a significant determinant of economic growth in an intermediate set of provinces. Road networks had a positive effect on provincial income for all Philippine provinces when examined as one group.

PUBLICATIONS: P. C. Frederiksen and R. E. Looney, "Road Investment and Regional Economic Development: A Philippine Case Study," International Journal of Transport Economics, (December 1982), pp. 335-348.

TITLE: Regional Development in Mexico

INVESTIGATORS: P. C. Frederiksen, Associate Professor of Economics, DRMEC, and R. E. Looney, Associate Professor of Economics, NSA.

SPONSOR: None

OBJECTIVE: To see whether economic overhead capital and social overhead capital have statistically significant different effects on Mexican economic growth.

SUMMARY: The paper suggests that Mexico's priority should focus on investment and then decision making. Also, the distinction must be made between investment in the more developed and the underdeveloped regions of the country.

PUBLICATIONS: R. E. Looney and P. C. Frederiksen, "A Programmed Approach Toward a Regional Expenditure Policy for Mexico," Journal of Developing Areas, (October 1982), pp. 1-12.

TITLE: Prospects for Economic Growth in Mexico

INVESTIGATORS: R. E. Looney, Associate Professor of Economics NSA, and P. C. Frederiksen, Associate Professor of Economics, DRMEC.

SPONSOR: None

OBJECTIVE: To evaluate alternative IMF proposals.

SUMMARY: A model of the Mexican economy was constructed to examine the impact of government fiscal activity under alternative stabilization programs. The results of the optimal control simulation suggests a critical element for success is the ability and willingness of the government to raise tax revenues.

PUBLICATIONS: R. E. Looney and P. C. Frederiksen, "The Feasibility of Alternative IMF-Type Stabilization Programs in Mexico, 1983-87," Journal of Policy Modeling. Forthcoming.

R. E. Looney and P. C. Frederiksen, "Prospects for Economic Stability in Mexico," Texas Business Review, (May - June 1983), pp. 117-119.

R. E. Looney and P. C. Frederiksen, "An Optimal Mexican Stabilization Program for the 1980's," Proceedings of December 1983 North American Economics and Finance Association Meetings. Forthcoming.

CONFERENCE PRESENTATION: R. E. Looney and P. C. Frederiksen, "An Optimal Mexican Stabilization Program," North American Economics and Finance Association Meetings, New York, December 1982.

TITLE: Research on the Sufficiency of Justification Hypothesis

INVESTIGATORS: James H. Morris, Associate Professor, DRMEC; David F. Caldwell, Assistant Professor, University of Santa Clara; Charles A. O'Reilly III, Associate Professor, University of California at Berkeley.

SPONSOR: None

OBJECTIVE: Design and conduct field experiments to represent insufficient and over justification conditions for tests of sufficiency of justification hypotheses and related effects in work organizations.

PUBLICATION: D. F. Caldwell, C. A. O'Reilly, and J. H. Morris. Responses to an organizational reward: A field test of the sufficiency of justification hypothesis. Journal of Personality and Social Psychology, 44, 506-514, 1983.

TITLE: Voluntary Union Membership, Communication, and Global Organization Performance in Public Human Service Organizations.

INVESTIGATORS: James H. Morris, Associate Professor, DRMEC, and Robert A. Snyder, Associate Professor, Northern Kentucky University.

SPONSOR: None

OBJECTIVE: Examine whether global organization performance in human service agencies is related to voluntary union membership levels among employees, and further, to examine the role of organization communication in performance and union membership decisions.

PUBLICATIONS:

J. H. Morris and R. A. Snyder. Organization Performance and Voluntary Union Membership Among Human Service Organizations. Journal of Occupational Psychology, 56, 183-190, 1983.

R. A. Snyder and J. H. Morris. Communication and Organization Performance, Journal of Applied Psychology. Forthcoming.

TITLE: Multiobjective Decision Techniques and Defense Analysis

INVESTIGATOR: R. L. Pirog, Assistant Professor of Economics, DRMEC

SPONSOR: None

OBJECTIVE: To analyze the interface of the managerial and analytical phases of the defense planning process.

SUMMARY: The study compares the traditional cost effectiveness framework with that of a multiobjective structure. The appropriateness of the problem format, the character of the choice set, and the latitude available to the decision maker are evaluated under each approach.

CONFERENCES: R. L. Pirog, "Multiobjective Decision Techniques and Defense Analysis," submitted to the American Academy of Management, Boston, MA, 12-15 Aug 1984.

TITLE: Planning, Public Goods, and Nonconvexitites in Economic Systems

INVESTIGATOR: R. L. Pirog, Assistant Professor of Economics, DRMEC

SPONSOR: None

OBJECTIVE: To analyze the properties of a general equilibrium system that must produce public goods characterized by nonconvex production sets.

SUMMARY: Nonconvex production sets for the public goods preclude the existence of prices to support Lindahl or Public Competitive Equilibrium Pareto efficient allocations can be shown to exist however, and are generally attainable through DVP planning processes with mild restrictions on the degree of nonconvexity.

CONFERENCES: R. L. Pirog, "Planning, Public Goods, and Nonconvexities in Economic Systems" at Western Economic Association Meetings, San Diego, CA, July 1980.

PUBLICATIONS: R. L. Pirog, "Planning, Public Goods, and Nonconvexities in Economic Systems." Submitted to Journal of Public Economics.

TITLE: Quantity and Quality Effects of Authorized Dealer Warrant Maintenance Agreements

INVESTIGATOR: D. C. Roberts, Assistant Professor of Economics, DRMEC; H. L. Gill, Assistant Professor of Economics, Air Force Institute of Technology

SPONSOR: None

OBJECTIVE: The study aims to investigate theoretically and empirically the effect on maintenance quantity and quality of warrantee agreements wherein warrantee maintenance is performed by manufacture authorized agents rather than non-authorized maintenance agents.

SUMMARY: A theoretical model was developed relating the behavior of manufacturers, manufacturer authorized maintenance agents, and non-authorized agents. Results derived from the model suggest that authorized and non-authorized maintenance agents should differ in both the quantity and quality of their warrantee maintenance products.

CONFERENCE PRESENTATIONS: D. C. Roberts and H. L. Gill, "Maintenance Quality and Authorized Service Contracts," ORSA/TIMS, October 1982.

D. C. Roberts and H. L. Gill, "Quality and Quantity Effects of Authorized Maintenance Contracts," Western Economic Association Meetings, July 1983.

TITLE: Expected Prices, Actual Prices, and Aggregate Output

INVESTIGATOR: D. C. Roberts, Assistant Professor of Economics, DRMEC

SPONSOR: None

OBJECTIVE: To examine the response of aggregate output to changes in actual and expected price level changes under conditions of imperfect information.

SUMMARY: The outcome of control efforts by monetary and fiscal authorities depends largely on the response of aggregate output to price level variations. The results presented in this study suggest that under conditions of imperfect information, the supply response of aggregate output depends on initial expected prices as well as how expected prices are formulated. Models that assume initial equality between expected and actual prices beg the question of price/output response and introduce the possibility of unintended effects of stabilization efforts.

PUBLICATION: D. C. Roberts, "Aggregate Supply and Initial Expected Prices." Submitted for publication to Journal of Macroeconomics.

Title: Spacecraft Contamination from Laser Exhaust

Investigator: Allen E. Fuhs, Distinguished Professor of Aeronautics

Sponsor: Defense Advanced Research Projects Agency

Objective: To determine the flux of backscattered molecules when an open-cycle laser is fired from a spacecraft.

Summary: The project was initiated late in FY'82 with several man-days effort to conduct a literature survey. During FY'83 computer codes for solving the span of flow from continuum through transitional to face-molecular were examined. The best approach is to use the Monte Carlo technique.

Application of Composite Materials to Helicopter Rotors and Airframes

igator: Dr. R. L. Foye, Adjunct Professor, Department of Aeronautics

r: U. S. Army Research and Technology Laboratory HQ (AVRADCOM)

ive: The primary objective was to develop the basis for a new composite laminate analysis procedure which would evolve into a failure criteria for laminates that was sensitive to delamination modes of failure and free edge effects. The secondary objective was to begin the development of a set of notes that summarized that part of the aerospace composite design experience that would be of future benefit to ground combat vehicle designers.

y: A laminate analysis model was developed based on lattice beam theory which was sensitive to all of the common failure modes of angle ply laminates. An iterative method of solution of the resulting equations was proposed. This solution contained all the characteristics observed in 3-D elasticity solutions to laminate response with free edge effects.

The initial aerospace composite summary of weight and cost savings results has developed into a longer term effort to produce a Composite Component Design Notebook that will also serve as a reference text in AE 4103.

ations: R. L. Foye, "A New Mechanics Model for Predicting Angle Ply Behavior," Presented at the 24th AIAA Structures, Dynamics and Materials Conference, Lake Tahoe, Nevada, May 1983.

R. L. Foye, "A Survey of Reported Weight and Cost Savings for Composite vs. Metal Airframes," Presented at the 42nd Annual Conference of Society of Allied Weight Engineers, Inc., Anaheim, California, May 1983.

Title:	Development and Use of a Centrifugal Diffuser Test Device (CDTD)
Investigators:	J. R. Erwin, Naval Air Systems Command Visiting Research Professor in Aeronautics, Dr. R. P. Shreeve, Director, Turbopropulsion Laboratory (TPL), Department of Aeronautics
Sponsor:	U.S. Army Research and Technology Laboratories (NASA Lewis Research Center)
Objective:	To develop a satisfactory method for testing diffusers for centrifugal compressors and to use the resulting facility to verify NASA computer codes.
Summary:	A novel device for generating and controlling an axi-symmetric flow into a typical centrifugal diffuser arrangement was built and installed in the low speed cascade building at TPL. Preliminary tests were conducted to investigate the ability to control swirl angle and case and hub boundary layers in the test device. The proposed high swirl angles were not achieved, though the technique of varying the angle was successful for a range of flow angle of 52° - 69° in the core. In order to obtain flow angles greater than 70° a modification to the device has been proposed. The control of the flow profile into the test section was found to be acceptable. An instrumentation layout has been designed to obtain the data required for code verification. A control volume analysis was made to calculate the flow produced by the test device. Comparison of analytical predictions with test results revealed differences in flow angle of up to 4°. A quasi-three dimensional computer code which takes into account the specific geometry of the test device will be used in order to achieve better results. Code verification tests using a 32-vane island diffuser will follow the final modifications of the facility now underway.
Thesis Directed:	P. Vidos, "Flow Generation in a Novel Centrifugal Diffuser Test Device," Master's Thesis, September 1983.

Title: Controls Research

Investigator: D. J. Collins, Professor of Aeronautics

Sponsor: NASA Dryden Flight Research Facilities

Objectives: Provide on-site instruction of a graduate level linear optimal control course AE 4342 and also provided consulting support to on-going controls research programs.

Summary: The work for this proposal has been completed. The advanced controls course AE 4342 has been presented at Edwards to approximately 20 people. The course was well received. Research on the UX 29 airplane was directed at obtaining lower order models which could be used in analyzing the airplane from a controls viewpoint. In particular, an effort was made to include the first five aeroelastic modes in the model. The original plant matrix of order 77 x 77 was reduced to a mode of order 37 x 37 with excellent representation of the system over the frequency range under consideration.

Title:	Laser Doppler Anemometry
Investigator:	D. J. Collins, Professor of Aeronautics;
Sponsor:	Naval Air Systems Command
Objective:	To develop LDA techniques to measure flow fields in turbomachinery. Particular interest will be paid to velocity mapping between rotor blades in a transonic compressor. A small part of the effort will be directed toward a thrust augmentor device.
Summary:	A completely computerized two-color laser anemometer has been developed. Extensive measurements have been made of complex flow fields. This work has been reported in the open literature. A further paper is now undergoing review. The base facility has obtained time-sampled data. This permits the determination of effectively instantaneous velocity profiles. The facility will be used in the transonic compressor to resolve uncertainties within rotor-steady wake regions and to measure two dimensional velocity profiles within the rotor passage. These measurements will be compared to present numerical predictions and can be used as a guide in model development. Further work should be directed at the development of a complete three-dimensional laser doppler anemometer facility.
Publication:	D. J. Collins, M. F. Platzer, J. C. Lai, and J. M. Simmons, "Experimental Investigations of Oscillating Subsonic Jets", Numerical and Physical Aspects of Aerodynamic Flows, Springer Verlag, 1982
Conference Presentation:	D. J. Collins, M. F. Platzer, and W. D. Harch, "A Presentation: Description of Velocity Field of a Vane Excited Jet," 8th Australian Fluid Mechanics Conference, 1982

e) An NWC program that simulated the effect of jamming on a radar PPI CRT was installed at NPS, and a User's Manual was prepared. The program illustrates the effectiveness of different types of jamming on a radar system.

f) A study was made of the effect of component redundancy on the probability of aircraft survival in an encounter with multiple damage mechanisms. The anti-aircraft simulation computer program P001 was modified to account for component redundancy.

Title: Aircraft Combat Survivability Studies

Investigator: R. E. Ball, Professor of Aeronautics

Sponsor: Naval Air Systems Command

Objective: To provide continuing technical support to the JTCG/AS. The following projects were active in FY'83:

a) Survivability Assessment in Conceptual Design

b) Survivability Assessment and Computer Graphics

c) Flight Control Survivability

d) The Installation and Review of PACAM at NPS

e) E W Simulations

f) The Effect of Component Redundancy on Aircraft Survivability

Summary:

a) The interactive digital computer program for assessing survivability developed last year at NPS, VISAP, was modified. Improved features were added and several bugs were eliminated. The program has been sent to several major aircraft companies and military organizations, including NAVAIR.

b) Improvements were made to the computer program GRPIP, the preprocessor for the computer programs P001 and MICE II developed at NPS. This program has been sent to one aircraft company.

c) The current flight control design philosophy, techniques, and requirements for fly-by-wire systems were reviewed, and guidelines for the design of fly-by-wire control systems for enhanced survivability were proposed.

d) The computer program for simulating the combat between several aircraft, PACAM, was installed on the NPS IBM 3033, and a User's Manual was prepared. The features of PACAM were evaluated as to the validity and accuracy.

DEVELOPMENT AND USE OF A CENTRIFUGAL DIFFUSE TEST DEVICE (CDTD)

Mr. Erwin and Dr. Shreeve have continued their work on CDTD. The results of their work for FY'83 are the following: A manual device for generating and controlling an axi-symmetric flow into a typical centrifugal diffuser arrangement was built and installed in the low speed cascade building. Preliminary tests were conducted and a modification to the device has been proposed. An instrumentation layout has been designed for code verification. A central volume analysis was made to calculate the flow procedures by the test device.

NUMERICAL MODELING OF THE FLOW IN TRANSONIC AXIAL COMPRESESSORS

Dr. Eidelman and Dr. Shreeve completed the development of computer code. Listing of the code for subsonic, transonic and supersonic flows in a channel with a circular arc bump, demonstrating accuracy and robustness of the code. The methods were then applied to calculate the transonic flow through a supercritical compressor cascade.

DETONATION TURBINE

Dr. Eidelman and Dr. Shreeve's work involves analytical and experimental investigation on the feasibility of a rotary detonation engine. A test stand to measure static torque of a rotary detonation chamber was assembled. The model was tested. Torque measurements were made. Series of firings were made for different fuel concentrations.

WAVE ROTORS AND WAVE ENGINES

Dr. Shreeve has done an extensive survey of publications and proposals related to wave rotor and cycle analyses. A Riemann problem solver code has been used to determine viable cycles for wave rotors. A method of characteristics code was developed as a flow solver. The design of a wave rotor experiment has been completed and the apparatus is in the procurment/assembly phase. Assembly and initial tests are expected in early 1984.

TRANSONIC COMPRESSOR INVESTIGATIONS

Dr. Shreeve has continued his investigations on transonic compressor. A single stage transonic axial research compressor testing and several unusual measurements techniques have been developed. In the past year, the "Dual-Probe Digital Sampling (DPDS)" technique was further developed. Application of the DPDS technique in a steady shear layer was examined in a laboratory rig. A cascade flow model of the rotor tip flow was modified.

DEVELOPMENT OF A TRANSONIC COMPRESSOR MODEL

Dr. Shreeve is continuing the development of a small transonic axial air compressor model and to establish methods for measuring performance and flow behavior.

The development of the test compressor and test rig hardware is directly associated with the transonic compressor investigation project. Flow velocity distributions into and between blade rows of the prototype stage have been neasured and compared with design distributions. The design of a new rotor to evaluate emerging computation methods for axial stages is planned.

CONTROLLED DIFFUSION BLADING DEVELOPMENT

Dr. Shreeve is trying to obtain data using subsonic wind tunnel to verify computational codes used in the design of controlled diffusion (CD) blading and to measure the performance of specific designs.

Two controlled diffusion (CD) blading designs are to be evaluated. A stator blade section designed and a rotor fan blade section are to be tested. Double-circular-arc (DCA) blading has been investigated. Loss coefficients, deviation angles, AVDR and surface pressure distributions were obtained. The china clay technique flow conditions.

ARTICULATE BEHAVIOR IN SOLID PROPELLANT ROCKET MOTORS

Professor Netzer and Powers continued combustion study of composite solid propellants using holography, high-speed motion pictures, light-scattering measurements and postfire particle/collection/scanning electron microscopic examination.

In the experiments conducted, monochromatic and high entensity white light were used successfully in obtaining high-speed motion picture of solid propellant strand combustion. Light scattering measurements were made. In addition, a technique has been developed for obtaining holograms within 2-D (cross-flows) motion environment.

METALLIZED SOLID FUEL RAMJET COMBUSTION

Professor Netzer has initiated experimental studies using a small two-dimensional combustor to obtain high-speed motion pictures of the metal combustor process.

The objective of this project is to conduct fundamental experimental and analytical studies to enhance the understanding of the combustion behavior of ramjets.

INVESTIGATION OF AEROELASTIC PHENOMENA IN TURBOMACHINES

Professor Platzer has continued to compile comprehensive review of the unsteady aerodynamic/aeroelastic phenomena occurring in turbomachines, to analyze blade cascade and to complete the investigation of vane-excited jets for use in thrust augmenting injectors.

The analysis of experiments on vane-excited subsonic jets was completed. Preparation of a Manual on Aeroelasticity in Axial Turbomachines was continued. Work was also continued in the analysis of supersonic flow past oscillating cascades with finite blade thickness and on compressible flow past oscillating wings.

COMPRESSOR TIP CLEARANCE EFFECTS

Dr. Shreeve has continued to investigate the effects of changes in the compressor tip clearance. The first measurements of the performance map and internal flow profiles have been obtained. Work was concentrated on redesign of inlet guide vanes. An analytical method has also been developed to predict exit angles from oscillating blade rows.

HIGH ENERGY LASER SYSTEM SAFETY

Professor Layton's research project objective is to provide technical support in the field of systems safety to the High Energy Laser Program.

This fiscal year, Professor Layton reviewed technical proposals for a shipborne laser system. He served as a member of the ad hoc committee to draft a Laser Safety Military Specifications.

INSPECTIONS TECHNIQUES FOR UNDERGROUND STEAM LINES

Professor Miller has continued his investigation and development of methods and techniques for activity level public works inspection of underground steam lines.

Field procedure for leak detection and a portable hand-held calculator have been developed and field tested. User's Manual incorporating a computer program for HP-H1 hand-held calculator has been written. A field service kit and User's Manual have been designed, fabricated and tested. Means for direct assessment of heat loss from buried steam lines have been developed and field tested. A first draft of all overall procedures/guidelines manual has been completed and forwarded for review.

SOLID FUEL RAMJET COMBUSTION

Professor Netzer has continued in the development of computer simulation of the combustion process, and in determining the effects of the combustor/inlet geometry and flow condition on the obtainable performance and on the occurrence of combustion pressure oscillation.

Initial work on the 3-D computer code for the SFRJ has been completed. Full regression rate profiles for bypass and side-dump geometries have been obtained. Experimental investigation was initiated to determine the combustion/flow process(es).

GAS TURBINE COMBUSTION AND TEST CELL EMISSIONS

Professors Netzer has continued his experiment to determine the effects of fuel additives and fuel composition on emitted particulate and NO_x levels.

During FY'83 a gas turbine combustor test facility was designed. Initial series of tests were conducted.

FLOW CONTROL FOR LASER TURRETS

Dr. Fuhs has continued his work on the oblique wing technology application to selected USN/USMC aircraft missions. For this project, a NASA Ames Research Center computer code, "Aircraft Synthesis Program," is being used in aircraft design.

SPACECRAFT CONTAMINATION FROM LASER EXHAUST

Dr. Fuhs has continued his study on the flux of backscattered molecules when an open-cycle laser is fired from a spacecraft. Literature survey was made in FY'82 and computer codes for solving the span of flaw were examined in FY'83.

SATELLITE VULNERABILITY TO HIGH ENERGY LASERS

This project was initiated in FY'83. Dr. Fuhs directed his effort to gathering and compiling background information vital to this project. During this period, a computer code Ground Up To Space (GUTS), was obtained from AFWL.

UNDERWATER SHAPED CHARGES

Dr. Fuhs' research project objectives are: The need to understand metal-steam combustion and the development of an ability to predict metal jets behavior from shaped charges fired underwater.

Series of tests were conducted using exploding wires in a variety of different environments. A computer modified program for supersonic blunt body flow is under development.

THRUST CALCULATION FEASIBILITY STUDY

Professors Gawain and Biblarz have continued their work on developing test procedure and associated data reduction/analysis.

Their work, at present, involves the modification of overhauled engines by using ground run-up testing. Tests were made and the technique used was found not feasible.

LASER DOPPLER ANEMOMETRY

Professor Collins has continued to develop LDA techniques to measure flow fields in turbomachinery. A computerized two-color laser anemometer has been developed. Extensive measurements of complex flow fields have been made. Further work will be directed at the development of a complete three-dimensional laser doppler anemometer facility.

DEPARTMENT OF AERONAUTICS

The research effort of the Aeronautics faculty covers a broad range of aeronautical engineering disciplines with special emphasis on Naval aviation problems.

AIRCRAFT COMBAT SURVIVABILITY STUDIES

Professor Ball has continued his research in various areas of aircraft survivability. Progresses were made and are as follows:

(a) Modified the interactive digital computer program for assessing survivability, VISAP; (b) Improvements were made to the computer program GRPIP; (c) Reviewed flight control design philosophy, techniques and requirements for fly-by-wire systems; (d) Installed on the NPS IBM 3033, computer program for simulating the combat between survival aircraft, PACAM; (e) An NWC program that simulates the effect of jamming on a radar PPI CRT was installed at NPS; and (f) A study of the effect of component redundancy on the probability of aircraft survival in encounter with multiple damage mechanism was made.

ELECTROHYDRODYNAMIC CONTROL IN GAS TURBINE COMBUSTORS

Professors Biblarz and Miller have continued a program to evaluate the merits of electrohydrodynamically modulated fuel injection for gas turbine combustors. A T-56 aircraft injector has been employed in the spray characteristics investigation and a T-56 injector and combustion can liner have been incorporated into a combustion apparatus.

CONTROLS RESEARCH

Professor Collins provided an on-site instruction of graduate level linear optimal control course and consulting support to an on-going controls research programs.

ADVANCED INDIRECT FIRE SUPPORT (AIFs) TECHNOLOGY TO NAVAL MISSIONS

Dr. Fuhs, with several research contractors, continued their investigation on cannon-launched, ramjet-propelled, guided projectiles for the U. S. Army/USMC 155, and their examination on the technical applications to the Navy missions.

DEPARTMENT

OF

AERONAUTICS

Title:	Studies of Metal/Steam Combustion
Investigator:	A. E. Fuhs, Distinguished Professor of Aeronautics and Space Systems
Sponsor:	Naval Surface Weapons Center, White Oak Laboratories
Objective:	To determine ignition conditions and combustion rates for various metals burning in steam.
Summary:	A combustion chamber was designed, built and utilized to investigate aluminum burning in steam, air, and various gas mixtures. Design of unique shaped charges was initiated; the s/c will be tested in FY84.
Publication:	A. E. Hallenbeck, Jr., "Preliminary Investigation of Aluminum Conbustion in Air and Steam", Naval Postgraduate School Thesis Report, NPS 67-83-001, March 1983.

Title:	Underwater Shaped Charges
Investigator:	Allen E. Fuhs, Distinguished Professor of Aeronautics
Sponsor:	Naval Surface Weapons Center
Objectives:	This project has two objectives and they are as follows: First, an understanding of metal-steam combustion is needed, and, second, an ability to predict behavior of metal jets from shaped charges fired underwater is to be developed.
Summary:	Penetration of the metal jet from an underwater shaped charge generates a vapor cavity and a bow shock wave. The metal jet penetrates supersonically relative to the water causing intense shock waves. Under certain circumstances, the metal jet reacts vigorously with the water releasing considerable chemical energy. In FY'82, a series of tests using underwater shaped charges was conducted at NSWC/WOL. In FY'83, tests were conducted using exploding wires in a variety of different environments including steam, air, nitrogen, vacuum, argan, etc. A computer program is being developed using a modified computer program developed by NASA Ames Research Center for supersonic blunt body flow.
Publication:	A. E. Fuhs, A. E. Hallenbeck, Jr., and J. Strott, " Combustion in Steam," AIAA Paper 84-0204, January 1984
Thesis Directed:	A. E. Hallenbeck, Jr., "Preliminary Investigation Aluminum Combustion in Air and Steam," NPS Thesis NPS67-83-001, March 1983.

Title:	Application of Advanced Indirect Fire Support (AIFS) Technology to Naval Missions
Investigator:	Allen E. Fuhs, Distinguished Professor of Aeronautics
Sponsor:	Defense Advanced Research Projects Agency
Objective:	Under AIFS sponsorship, several contractors are investigating cannon-launched, ramjet-propelled, guided projectiles for U.S. Army/USMC 155mm. The work at NPS is to examine Navy missions for which the technology is applicable. FY'83 was the fourth year of a continuing effort. Funding has been provided for FY'84.
Summary:	One advantage of a thrust-equals-drag projectile, which can be achieved using the ramjet, is immunity to winds. A study continues on the ballistics of a projectile when when thrust does not exactly equal drag. Calculation of projectile dispersion using a six-degree-of-freedom computer code is being accomplished. The work on Gradient Refractive INdex (GRIN) lens for ramjet missiles continues.
Conference Presentation:	A. E. Fuhs, "Overview of NPS/AIFS Results to Date," Progress Report presented at DARPA Program Review, McLean, Virginia, 18-20 April 1983.
Patent Application:	A. E. Fuhs, "Spike Lens Design Using Gradient Refractive Index," Application: 21 July 1982, Navy Case No. 66,954.

Title:	Flow Control for Laser Turrets
Investigator:	Allen E. Fuhs, Distinguished Professor of Aeronautics
Sponsor:	NASA Ames Research Center
Objective:	The objective is to apply oblique wing technology to selected USN/USMC aircraft missions. Aircraft will be designed using a NASA Ames computer code which is known as Aircraft Synthesis Program.
Summary:	Oblique wing technology offers considerable advantages to aircraft which must cruise transonically and have long loiter time. Aircraft with oblique wings may have supersoinc dash capability. The project spans two fiscal years, FY'83 and FY'84.

Title: Thrust Calculation Feasibility Study

Investigators: T. H. Gawain, Professor of Aeronautics and
O. Biblarz, Associate Professor of Aeronautics

Sponsor: Naval Air Engineering Center

Objective: To develop a testing procedure and associated data reduction/analysis which is both technically superior and less costly than the present electromechanical method.

Summary: At present, overhauled engines are modified by ground run-up testing which typically involves an electromechanical method with calibrated load cells. This technique is difficult, expensive, and of somewhat dubious accuracy. A suitable alternative might be based on the calculation of thrust from calculation of thrust from measurements of static wall pressure at or near the inlet section of the engine discharge nozzle. Tests on the TF41 engines are presently under consideration.

Publication: T. H. Gawain and O. Biblarz, "Measurement and Calculation of Jet Engine Static Thrust," Naval Air Engineering Center Technical Report NAEC 92-174, March 1983

Title: Electrohydrodynamic Control of Fuel Injection in Gas Turbine Combustors

Investigator: J. A. Miller, Associate Professor of Aeronautics and O. Biblarz, Associate Professor of Aeronautics

Sponsor: Naval Air Systems Command

Objective: A program is in progress to evaluate the merits of electrohydrodynamically - modulated fuel injection for gas turbine combustors. Fuel injection spray characteristics are being studied with an optical technique and the effects on combustion are being evaluated from measurements of combustion product temperatures. The goal of this program is to evolve practical means of using electrostatic elements within the combustion chamber to control fuel spray characteristics and thus optimize combustion efficiency for a variety of gas turbine fuels. The electrical probes considered are rugged and may be inserted with minimum penalty during engine overhaul.

Summary: A T-56 aircraft injector has been employed in the spray characteristics investigation and a T-56 injector and combustion can liner have been incorporated into a combustion apparatus. Preliminary results indicate that a centerline electrode charged with voltages typical of spark plugs, (30kV), is capable of producing large charges in fuel spray characteristics. It has been possible to burn a non design fuel such as diesel in the combustors. Some practical difficulties in maintaining electrode voltage in the presence of ionizing flame fronts has been encountered and a development program to overcome this difficulty is underway. Additionally, studies are being conducted to better understand the effects of electrostatic fields on spray characteristic modification and the subsequent implications to the burning process and combustion efficiency.

Theses Directed: R. J. Laib, "Design of an Apparatus for the Study of EHD Control of a Spray from Fuel Injectors in a Gas Turbine," Aeronautical Engineer's Thesis, October 1982.

J. A. Mauroudis, "Experimental Study of Electrostatically Modified Fuel Spray on Gas Turbine Combustor Performance", Master's Thesis, December 1982.

Patent Application: O. Biblarz, J. A. Miller, and R. J. Laib, "EHD Control of Fuel Injection in Gas Turbines," Navy Case No. 65,213.

Title: Inspection Techniques for Underground Steam Lines

Investigator: J. A. Miller, Associate Professor of Aeronautics

Sponsor: Naval Civil Engineering Laboratories

Objective: Investigate and develop methods and techniques for activity level public works inspection of underground steam lines including development of (1) sulphur hexaflouride leak detection field procedures; (2) heat loss measurement field procedures; and (3) overall procedures/guidelines manual.

Summary: A self-contained field procedure for the detection of leaks in the protective shell of direct burial prefabricated steam lines using sulphur hexaflouride as a leak detectant and a portable hand-held capture detector has been developed and field tested. A User's Manual has been written incorporating a computer program for the HP-41 hand-held calculator which calculates all of the necessary data in response to plain language input prompts. A field service kit including the detector, gas mixing manifold and User's Manual has been designed, fabricated, and tested. It was recently conveyed to NEESA for incorporation into the operational maintainance system. Means for the direct assessment of heat loss from buried steam lines have been developed and field tested and are currently under assessment and refinement. A first draft of an overall procedures/guidelines manual has been completed and forwarded through NCEL to NAVFAC for comment prior to publication of a field service manual.

Publications: J. A. Miller, "The Detection of Leaks in Buried Pipes Using Sulphur Hexaflouride as a Tracer Gas," American Society of Mechanical Engineers, The Journal of Engineering for Power, Transactions of the ASME (forthcoming).

J. A. Miller, "The Location of Leaks in the Sheath of Pressure Testable Direct Burial Steam Distribution Conduits," Field Service Manual, NCEL, (in progress).

J. A. Miller, J. C. King, and D. M. Sneed, "Performance Evaluation and Energy Conservation in Central Steam Distribution Systems," Draft Report NAVFAC Field Service Manual, (in progress).

sis Directed: W. Neboshynsky, "Field Inspection Techniques for Buried Steam Distribution Lines," Master's Thesis, December 1982.

Title: Solid Fuel Ramjet Combustion

Investigators: D. W. Netzer, Professor of Aeronautics

Sponsor: Naval Weapons Center

Objectives:

1. To continue development of computer simulation of the combustion process.

2. To determine the effects of combustor/inlet geometry and flow condition on the obtainable performance and on the occurrence of combustion pressure oscillations.

Summary: Initial work has been completed on the 3-D computer code for the SFRJ. Fuel regression rate profiles have been obtained for bypass and side-dump geometries with and without inlet air swirl. Current efforts are directed at incorporation of radiation heat transfer to the fuel surface. An experimental investigation was initiated to determine the combustion/flow process(es) that is capable of low frequency coupling with the inlet air feed system.

Presentations:

M. E. Metochianakis and D. W. Netzer, "Modeling Solid Fuel Ramjet Combustion Including Radiation Heat to the Fuel Surface," Journal of Spacecraft and Rockets, Volume 20, No. 4 (July-August 1983), p. 405.

D. W. Netzer and U. Katz, "Combustion Pressure Oscillations in Solid Fuel Ramjets," ONR/AFOSR Workshop on Mechanisms of Instability in Liquid Fueled Ramjets, 16-18 March 1983, Chemical Propulsion Information Agency Publication 375, (April 1983), pp. 71-87.

Thesis Directed: G. A. Begley, Jr., "An Experimental Investigation of the Combustion Behavior of Solid Fuel Ramjets," Master's Thesis, December 1982.

tle: Effects of Smoke Suppressant Fuel Additives and Fuel Composition on Gas Turbine Combustor Emissions

vestigator: D. W. Netzer, Professor of Aeronautics

onsor: Naval Air Propulsion Center

jective: Experimentally determine the effects of fuel additives and fuel composition on emitted particulate and NO_x levels.

mmary: A gas turbine combustor test facility was designed and constructed, and an initial series of tests were conducted to determine combustor operating characteristics and the adequacy of the newly constructed combustor diagnostic apparatus. The facility utilizes a T63 combustor and can be operated with vitiated air inlet temperatures to 600°K. Water cooled gas/particulate and stagnation temperature probes were utilized in a combustor aft-end location for initial check-out tests. Three-wavelength light transmission measurements through the combustor have been made to determine the mean soot size and exhaust capacity is also being measured. Currently, a screening test series is being conducted using ten JP composition and three fuel additives. Future studies will be directed at detailed measurements of several fuel/additives using the sampling probes together with the light transmission measurements.

ieses Directed: R. W. Dubeau, "A Gas Turbine Combustor Test Facility for Fuel Composition Investigation," Master's Thesis, June 1983.

A. C. Krug, "An Experimental Investigation of Soot Behavior in a Gas Turbine Combustor," Aeronautical Engineer's Thesis, June 1983.

TITLE: Particulate Behavior in Solid Propellant Rocket Motors

INVESTIGATORS: D. W. Netzer, Professor of Aeronautics
J. P. Powers, Professor of Electrical Engineering

SPONSOR: Air Force Rocket Propulsion Laboratory

OBJECTIVE: Holography, high speed motion pictures, light scattering measurements and postfire particle collection/scanning electron microscopic examination are to be used to study the combustion of composite solid propellants. The immediate goal of the study is to evaluate the relative advantages and disadvantages of the different experimental techniques for obtaining two-phase flow characteristics within the combustion environment of a solid propellant grain.

SUMMARY: Monochromatic and high intensity white light have both been successfully used to obtain high speed motion pictures of a solid propellant strand combustion in which the flame envelopes surrounding the aluminum particles have been eliminated.

Light scattering measurements have been made to determine the particulate D_{32} at both the entrance and exit of a small 3-D motor. Successful measurements have been made but the major difficulty is elimination of binder/inhibitor solid products from the exhaust gas.

A technique has been developed for obtaining holograms within a 2-D (cross-flow) motor environment. Currently pressures have been limited to 500 psi and metal content to 5% by weight.

An investigation was initiated to develop a method for automatic retrieval of particulate size and location data from holograms. The method is based on a computer-controlled Quantimet 720 Image analyzer. The analyzer was installed and preliminary measurements were obtained from photographs of hologram reconstructions.

PUBLICATIONS: "An Investigation of Experimental Techniques for Obtaining Particulate Behavior in Metallized Solid Propellant Combustion," R. G. Cramer, R. J. Hansen, T. R. Gillespie III, R. J. Edington, M. A. McInnis, P. J. Hickey, and D. W. Netzer, Proceedings of the 19th JANNAF Combustion Meeting, 4-7 October 1982, Chemical Propulsion Information Agency, Pub. No. 366, Vol. I, pp. 29-34, October 1982.

e:	Investigation of Aeroelastic Phenomena in Turbomachines
stigator:	M. F. Platzer, Professor of Aeronautics
sor:	Naval Air Systems Command
ctive:	To compile a comprehensive review of the unsteady aerodynamic/aeroelastic phenomena occurring in turbomachines, to analyze supersonic flow past oscillating blade cascades and to complete the investigation of vane-excited jets for use in thrust augmenting ejectors.
ary:	The analysis of experiments on vane-excited subsonic jets was completed. It was found that an oscillating vane located in the potential core of a two-dimensional jet is an effective method of increasing jet entrainment. The process appears to result from manipulation of the naturally occuring vortex structures of the jet. Work was continued on the preparation of a Manual on Aeroelesticity in Axial Turbomachines. The current status of this project was summarized in a memorandum submitted to AGARD and all sponsors (ONR, NAVAIR, AFOSR) in September 1983. Work was also continued in the analysis of supersonic flow past oscillating cascades with finite blade thickness and on compressible flow past oscillating wings. A new approach to analyze subsonic, transonic, and supersonic flow past oscillating low aspect ratio wings was developed and summarized for publication.

itle: Controlled Diffusion Blading Development

nvestigator: Dr. R. P. Shreeve, Director, Turbopropulsion Laboratory (TPL), Department of Aeronautics

ponsors: Naval Air Systems Command, NASA Lewis Research Center and Sundstrand Corporation

bjective: To obtain data using a large (60" x 10") subsonic cascade wind tunnel to verify computational codes used in the design of controlled diffusion (CD) blading and to measure the performance of specific designs.

ummary: Two CD blading designs are to be evaluated. First, for NASA, a stator blade section designed using a numerical optimization procedure is being tested. The results will be compared with code predictions and with results previously obtained with a double-circular-arc (DCA) cascade which the CD blading was designed to replace. Second, for Sundstrand Corporation, a rotor fan blade section is to be tested. To date, the DCA blading has been investigated over its useful incidence range. Loss coefficients, deviation angles, AVDR and surface pressure distributions were obtained. The china clay technique was used to analyze surface flow conditions, including boundary layer transition and this allowed interpretation of the blade-element loss data. Following refinements to the facility, the flow quality is now considered to be excellent and testing of the NASA CD stator design has begun.

'heses Directed: J. S. Himes, "Report of Tests of a Compressor Configuration of DCA Blading," Master's Thesis, June 1983.

A. G. McGuire, "Determination of Boundary Layer Transition and Seperation on Double Circular Arc Compressor Blades in a Large Subsonic Cascade," Master's Thesis, September 1983.

ed: J.J. Hall, "On the Unsteady Response of an Oceanic Front to Local Atmospheric Forcing," Master's Thesis, June 1983.

D.G. Markham, "Ocean Mixing and Circulation Response in the Marginal Ice Zone," Master's Thesis, June 1983.

itle: Studies of the Oceanic Planetary Boundary Layer

nvestigator: R.W. Garwood, Jr., Associate Professor of Oceanography

ssociated nvestigator: P.C. Gallacher, Adjunct Instructor of Meteorology

ponsor: Office of Naval Research

bjective: The long range scientific objective of this research is to understand the role of the oceanic planetary boundary layer (OPBL) in the distribution of energy, momentum and mass in the upper ocean in response to atmospheric forcing.

ummary: Mathematical models of entrainment and ocean mixing are developed and verified by comparison of numerical simulations with oceanic observations for such processes as the unsteady response of the mixed layer to changing atmospheric forcing and the response of upper ocean density fronts to local atmospheric forcing. Other processes involving application of turbulence closure modeling include: i) an investigation of the role of planetary rotation upon entrainment in deep mixed layers; ii) the use of nutrient data as a chemical tracer of mixed layer dynamics; iii) the nature and importance of coupling and feedback between the OPBL and the marine atmospheric boundary layer (MABL); and iv) the effect of interior motion on the generation of sea surface temperature anomalies

Conference Presentations:

R.W. Garwood, L.K. Coachman, "Entrainment of Tracers by the Surface Mixed Layer," Annual Meeting of the American Geophysical Union, San Francisco, December 7, 1983; in EOS, vol. 63, no. 45, p. 980.

P.C. Gallacher, "Rotation Stress in Turbulent Planetary Boundary Layers: Implications for Equatorial Mixed Layers," XVIII General Assembly of the International Union of Geodesy and Geophysics, Hamburg, August 1983.

P. Muller and R.W. Garwood, "Interaction Between Mixed Layer and Interior," Annual Meeting of the American Geophysical Union, San Francisco, December 10, 1983, in EOS, vol. 63, no. 45, p. 1006.

P. Muller and R.W. Garwood, "The Effect of Interior Motions on Sea Surface Temperature, Mixed Layer Depth, and Structure of the Seasonal Thermocline," XVIII General Assembly of the International Union of Geodesy and Geophysics (IAPSO), Hamburg, August 1983.

K. Davidson and R.W. Garwood, "Coupled Oceanic and Atmospheric Mixed Layer Model," XVIII General Assembly of the International Union of Geodesy and Geophysics, Hamburg, August 1983.

Conference Presentations:

G. W. Lundell, G. H. Jung and C. R. Dunlap, "Rapid oceanographic data gathering: Some problems in using remote sensing to determine the horizontal and vertical thermal distributions in the Northeast Pacific Ocean," Annual Fall Meeting, American Geophysical Union, San Francisco, CA, 7-5 December 1982.

G. H. Jung and S. A. Cox, "Satellite indicators of subsurface features important to acoustics transmission in the ocean," Annual Spring Meeting, American Geophysical Union, Baltimore, Md, 30 May-3 June 1983.

Thesis Directed:

T. A. Howell, "A statistical approach for determining subsurface thermal structure from sea surface temperature in the Northeast Pacific Ocean," Master's Thesis, June 1983.

Title: Upper Ocean Acoustic Effects

Investigators: C. R. Dunlap, Adjunct Professor of Oceanography; Glenn H. Jung, Professor of Oceanography; R. H. Bourke, Associate Professor of Oceanography; and R. W. Garwood, Jr., Associate Professor of Oceanography

Sponsor: Naval Ocean Systems Center

Objectives: (1) To understand and predict how environmental phenomena in the upper ocean affect the acoustic transmission loss from a submarine acoustic source, especially as the target changes operating depth, (2) To study relations between the remotely-sensed temperature field and the observed subsurface thermal structure in the northeast Pacific Ocean.

Summary: The second objective, involving ocean temperature field relations, has been the focus of the FY83 studies. Bathythermograph data, from the USNS SILAS BENT along a north-south track in the northeastern Pacific Ocean taken in September 1977, were analyzed statistically to find possible association between the subsurface (vertical) thermal structure and sea surface temperature. Strongly correlated variables (thermocline gradients, mixed layer depth, and location of the seasonal and main thermoclines) within the vertical temperature profile were used with linear regression methods to form empirical relationships. These generated equations then were used to define subsurface thermal structure from only an input of sea surface temperature. Comparison testing used bathythermograph data removed from the primary regression data both in time and space. Results indicated successful application within a water mass domain with uniformly changing characteristics.

Publication: T. A. Howell in conjunction with G. H. Jung and C. R. Dunlap, "A statistical approach for determining subsurface thermal structure from sea surface temperature in the Northeast Pacific Ocean," NPS Technical Report, #68-83-003, June 1983.

Title:	Environmental Acoustic Studies of Acoustic Signal Transmission in the Wavenumber Domain
Investigators:	C. R. Dunlap, Adjunct Professor of Oceanography, and A. B. Coppens, Associate Professor of Physics
Sponsor:	Naval Ocean Research and Development Activity
Objective:	To gain a better technical understanding of the Wavenumber Technique (WT), which is a relatively new method of underwater sound transmission analysis.
Summary:	Using the split-step Fourier transform method for the Parabolic Equation transmission loss model, the wavenumber technique was analyzed under various environmental conditions. The WT appears to be valid with respect to the Lloyd Mirror effect. Early results indicate it might be used operationally in target depth determination. The WT is being investigated also by use of the IFD Parabolic Equation model.
Publication:	A. B. Coppens, "An introduction to the parabolic equation for acoustic propagation," NPS Technical Report, # 61-83-002, November 1982.
Conference Presentation:	J. Blanchard and C. R. Dunlap, "Environmental acoustic studies of acoustic signal transmission in the wavenumber domain," DARPA Workshop on Fixed Distribution Systems, Applied Research Laboratory, University of Texas, Austin, Texas, September 1983.
Thesis Directed:	B. B. Stamey, "Preliminary investigation of the environmental sensitivity of acoustic signal transmission in the wavenumber domain with respect to source depth determination," Master's Thesis, 1982.

Title:	Environmental Acoustic Studies of Vertical Line Array Sensors
Investigators:	C. R. Dunlap, Adjunct Professor of Oceanography; G. H. Jung, Professor of Oceanography, and R. H. Bourke, Associate Professor of Oceanography
Sponsor:	Antisubmarine Warfare Systems Project Office
Objective:	To gain a better technical understanding of VLA performance, operational utilization, and environmental acoustic support aids.
Summary:	Vertical Line Array Difar (VLAD) data were obtained from PAC/LANT fleet operations which used VLAD, DIFAR and OMNI (57/41B) sonobuoys. All VLAD data were analyzed using an Ambient Noise Directionality Estimator (ANODE) provided by the Naval Air Development Center. ANODE data and PHITARV estimates of noise gain from Fleet Numerical Oceanography Center were then compared with VLAD sonobuoy performance. Wide band tape recordings of the VLAD data were acquired for further analysis in FY84.

Title: Ambient Noise Array Characterization; Data Base Development

Investigators: C. R. Dunlap, Adjunct Professor of Oceanography; G. H. Jung, Professor of Oceanography, and R. H. Bourke, Associate Professor of Oceanography

Sponsor: Naval Electronic Systems Command

Objective: To characterize and predict how environmental phenomena determine and otherwise affect the ambient noise received at surveillance arrays.

Summary: (1) A long-term ambient noise data base acquired from the Norwegian Sea was analyzed for the seasonal biological and wind effects discovered in earlier studies using similar but independent data. Wind effects were not well correlated in the new study, which has been reported as a technical report and thesis. (2) At the Sponsor's direction, personnel of the Environmental Acoustics Research Group participated in assessment of high latitude environmental acoustics of the Bering Sea; two classified surveillance data bases were developed for future analysis.

Publication: C. R. Dunlap and G. H. Jung, "Satellite detection of anomalies in ocean ambient noise?", Abstract in Journal, Acoustical Society of America, Suppl. 1, Vol. 72 p. 5-2.

Conference Publication: C. R. Dunlap and G. H. Jung, "Satellite detection of anomalies in ocean ambient noise?", Fall 104th Meeting, Acoustical Society of America, Orlando, Fl, 8-12 November 1982.

it compares spectrally the FNOC surface analyses with direct observations from NDBC buoys. The sponsor is the Office of Naval Research.

S.P. Tucker is investigating the distribution of the spectral irradiance of natural light and the optical beam spread function of the ocean. The R/V ACANIA is used. The sponsor is DARPA.

ENVIRONMENTAL ACOUSTICS

G.H. Jung, R.H. Bourke, C.R. Dunlap and R.W. Garwood study relations between atmospheric and oceanic variations and long-range, low-frequency sound propagation and ambient noise in the North Pacific Ocean. Satellite IR imagery is used to infer and interpret oceanic and acoustic variability. The sponsor is NOSC (for COSP and NAVELEX).

C.R. Dunlap, G.H. Jung, and R.H. Bourke are developing ambient noise data bases for the North Pacific and the Norwegian Sea in order to characterize ambient noise received at hydrophone arrays. The sponsor is NAVELEX (PME-124).

operations. The sponsor is the Arctic Submarine Laboratory, NOSC.

OPEN OCEAN STUDIES

R.W. Garwood, in conjunction with R.L. Elsberry and R.L. Haney of the Department of Meteorology, is modeling upper ocean thermal structure. Their investigations of the response of the ocean surface turbulent boundary layer to atmospheric forcing have led to the devleopment of models that can be used to compute upper ocean thermal structure changes if the atmospheric conditions are known. The sponsor is the Office of Naval Research. This effort has led to an applied research program in which the models are used to aid in the analysis of the upper ocean thermal structure, especially in those regions of the ocean that lack frequent observations. NORDA is the sponsor.

A.J. Willmott and M.M. Rienecker are conducting a theoretical study of the role in the Mendocino Escarpment waveguide for topographic Rossby waves. The sponsor is the Office of Naval Research.

J.L. Mueller is investigating the distribution of upper ocean optical properties associated with fronts and eddies in the California Current, and their influence on satellite imagery visualizations of such. The R/V ACANIA is used. The sponsor is the Office of Naval Research.

J.L. Mueller and S. Aranuvachapun are investigating marine aerosol estimation from the Nimbus-7 Coastal Zone Color Scanner (CZCS) in support of electro-optical propagation forecasts for weapons systems. NEPRF is the sponsor.

J.L. Mueller is investigating the effects of horizontal variability in ocean properties on the validity of optical propagation predictions based on one-dimensional models of the upper ocean. The R/V ACANIA is used, especially in the large field experiment called ODEX. This is part of a Selected Research Opportunity (SRO) program sponsored by ONR in support of the proposed Strategic Laser Communications (SLC) system.

T.R. Osborn and R.G. Lueck are designing, building, testing and using horizontal and vertical sampling systems for ocean turbulence. They make measurements from ships (including the R/V ACANIA) and submarines, and in the North Atlantic, North Pacific, and Equatorial Pacific. The sponsors are the Office of Naval Research, NORDA, and National Science Foundation.

C.N.K. Mooers, M.M. Rienecker, and J.A. Smith are conducting an ocean prediction study in collaboration with Harvard using the Harvard statistical-dynamical model for open domains. The study is presently focused on eddies, fronts, and jets in the California Current System. Ten synoptic realizations of the upper ocean have been acquired with hydrographic sampling from the R/V ACANIA for the purpose of numerical simulation studies. An ancillary study of atmospheric forcing in the Northeast Pacific is in progress;

DEPARTMENT OF OCEANOGRAPHY

The research program of the Department of Oceanography may be considered under four headings, according to the facilities utilized and topics considered: coastal ocean studies; near-shore processes studies; arctic studies, open ocean studies; and environmental acoustic studies.

COASTAL OCEAN STUDIES

J.B. Wickham pursued the processing of data from a field study focused on the California Undercurrent. the field study included (1) a year's continuous monitoring of the core of the Undercurrent with an array of moored current meters, and (2) a broader monthly sensing of the region with densely-spaced, mass-field profiling. The study region is one of relatively uncluttered sea floor topography on the continental slope off Big Sur. The sponsors of the earlier phases were the NPS Research Foundation and NASA. The MMS/OCS program has sponsored the analysis phase, which has involved C.N.K. Mooers.

E.C. Haderlie uses R/V ACANIA to study the biology of stone and wood boring organisms in the deeper waters of Monterey Bay. His purpose is to determine and identify the vertifical and horizontal distribution of these boriers as well as their growth rates, settlement times, and destructive effects. The sponsor is the Office of Naval Research.

E.D. Traganza uses the R/V ACANIA in a study of the chemical mesoscale associated with ocean fronts in the coastal upwelling region off Pt. Sur. Cruises are coordinated with satellite imagery obtained from the National Environmental Satellite Service at Redwood City. This study attempts to link physical, chemical, and biological properties in this region. The sponsor is the Office of Naval Research.

NEARSHORE PROCESSES STUDIES

E.B. Thornton is studying the kinematics and energetics of breaking waves in the surf zone. His research is based on measurements of water particle motion within the surf zone. The sponsor is the Office of Naval Research.

E.B. Thornton is developing criteria for breaking waves based on field measurements. The National Science Foundation is the sponsor.

ARCTIC STUDIES

R.G. Paquette and R.H. Bourke used U.S. Coast Guard icebreakers to observe and analyze ocean fronts and thermal fine-structure near the ice margin in the East Greenland Current. These studies have applications for enviromental acoustics and under-ice submarine

DEPARTMENT

OF

OCEANOGRAPHY

Title: Wave Rotors and Wave Engines

Investigator: Dr. R. P. Shreeve, Director, Turbopropulsion Laboratory (TPL), Department of Aeronautics

Sponsor: NPS Foundation Research Program

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

Summary: An extensive literature survey of publications and proposals related to wave rotor and cycle analyzes has been carried out. A Riemann problem solver code has been used to determine viable cycles for wave rotors, with special emphasis on an impulse turbine mode application. A method of characteristics (MOC) code was developed as a flow solver to partially predict the effect of wave structure in the rotor. This development highlighted some of the shortcomings of the MOC techniques and outlined the need for a unified and comprehensive code which can solve the flow structure in detail. Work has been initiated in this direction. The literature search indicated the lack of a theoretical analysis of the wave phenomena in any one class of wave rotors. Such an analysis has been started (presently for one class of wave rotors), and is expected to give some insight into the constraints and conditions required for efficient operation of these devices. The analysis is based on unsteady gasdynamical equations. The design of a wave rotor experiment has been completed and the apparatus is in the procurement/assembly phase. Assembly and initial tests are expected in early 1984.

Publications: S. Eidelman, A. Mathur, R. P. Shreeve and J. Erwin, "Application of Riemann Problem Solvers to Wave Machine Design," AIAA Technical Note (forthcoming).

R. P. Shreeve, A. Mathur. S. Eidelman and J. Erwin, "Wave Rotor Technology Status and Research Progress Report," Naval Postgraduate School Report No. NPS67-82-014PR, November 1982.

Conference Presentation: A. Mathur, "Wave Rotor Research Program at TPL, Naval Postgraduate School," Seminar held at Mathematical Sciences Northwest, Seattle, Washington, August 1982.

Title: Transonic Compressor Investigations

Investigator: Dr. R. P. Shreeve, Director, Turbopropulsion Laboratory, Department of Aeronautics

Sponsor: Naval Air Systems Command

Objective: To understand three-dimensional and unsteady effects and to obtain data with which to assess design and analysis methods for transonic blading.

Summary: A single stage transonic axial research compressor and test rig and several unusual measurement techniques have been developed toward the present study. In the past year, the "Dual-Probe Digital Sampling (DPDS)" technique was further developed and problems arising in interpreting velocity vector measurements in unsteady rotor wakes were identified and analyzed. Application of the DPDS technique in a steady shear layer was examined in a laboratory rig. Further work is underway to quantify errors die to sample averaging and other unsteady effects. The time-mean flow profiles are being reexamined to verify that the flow path and rotor designs give conditions which are to a quality sufficient for meaningful study of unsteady effects. Kulite transducer measurements were made at the case wall and showed bi-stable rotor-shock wave behavior at transonic conditions. A cascade flow model of the rotor tip flow was modified to include a back pressure control valve. Comparisons of cascade and compressor measurements with predictions of the Godunov code developed by Eidelman are planned.

Publications: R. P. Shreeve and F. Neuhoff, "Measurements of the Flow from a high Speed Compressor Rotor Using a Dual Probe Digital Sampling (DPDS) Technique," ASME paper 83-GT-215, 28th International Gas Turbine Conference, Phoenix, Arizona, March 1983.

R. P. Shreeve, F. Neuhoff, H. J. Heinemann and J. E. Hammer, "Experience in the Development of Computer-Controlled High Response Probe Diagnostics for Turbomachines," 6th International Symposium on Air-Breathing Engines, Paris, France, June 1983.

Thesis Directed: D. W. Cornell, "Experimental Determination of the Relative Flow at the Tip of a Transonic Axial Compressor Rotor," Master's Thesis, September 1983.

Title:	Development of a Transonic Compressor Model
Investigator:	Dr. R. P. Shreeve, Director, Turbopropulsion Laboratory (TPL), Department of Aeronautics
Sponsor:	Naval Air Systems Command
Objective:	To develop a small transonic axial air compressor model and methods for measuring performance and flow behavior.
Summary:	Associated with the project "Transonic Compressor Investigations" is the development of the test compressor and test rig hardware to design speeds of 30,460 RPM. Flow velocity distributions into and between blade rows of the prototype stage have been measured and compared with design distributions. Through-flow velocities less than design, giving incidence angles larger than design, were found at peak efficiency conditions. Modification of the inlet flow path, in particular, the spinner geometry is required to achieve more favorable meridional velocity distributions. Proposed modifications are being analyzed computationally. The design of a new rotor to evaluate emerging computation methods for axial stages is planned in collaboration of the Fan and Compressor Branch of NASA Lewis Research Center.
Publication:	J. R. Erwin, "A Review of the Design of the NPS/TPL Transonic Compressor," Contractor Report, NPS67-83-001CR, March 1983.

Title: Biology of Stone and Wood Boring Animals in the Monterey Submarine Canyon and the Deeper Waters off the Central California Coast

Investigator: E. C. Haderlie, Distinguished Professor of Oceanography

Sponsor: Ocean Sciences and Technology Division, Office of Naval Research

Objectives: To determine the vertical and horizontal distribution of stone and wood boring marine animals of the deeper water of Monterey Bay and offshore, and to determine the rates of destruction of wood, stone, concrete and various plastics. To determine the mechanisms used by bivalve molluscs in boring into hard stone.

Summary: During the past year emphasis has been on the mechanisms used by certain bivalve molluscs in penetrating stone. Electrophysiological studies in cooperation with scientists from the Woods Hole Oceanographic Institute have indicated that the clams are using the shells to mechanically erode very hard rock. Studies are now in progress on the micro-architecture of the shells of these molluscs to determine how a shoft shell can wear away hard rock.

Publications:

E. C. Haderlie, "Long-term natural resistance of some central American hardwoods to attacks by the shipworm Bankia setacea and the Gribble Limnoria quadripunctata in Monterey harbor," The Veliger, 25 (January 1983), 182-185.

E. C. Haderlie, "Depth distribution and settlement times of the molluscan wood borers Bankia setacea and Xylophaga washingtona in Monterey bay," The Veliger, 25 (April 1983), 339-342.

E. C. Haderlie, "Monitoring growth rates in wood- and rock-boring marine bivalves using radiographic techniques," In Biodeterioration V, 304-318, edited by T. A. Oxley and S. Berry, New York, John Wiley and Sons, 1983.

Title: Dissipation Rates, Energetics, and Diffusion in Warm Core Rings

Investigators: R. G. Lueck, Adjunct Research Professor of Oceanography, and T. R. Osborn, Professor of Oceanography

Sponsor: National Science Foundation

Objective: The purpose of this research is to analyze and interpret turbulence and velocity data collected in Warm Core Rings 82-B and 82-H in 1982 for the Warm Core Rings Project. The objective is to produce profiles of the rate of dissipation of turbulent kinetic energy and vertical shear and to relate these to the large scale hydrographic and dynamic features of the rings.

Summary: Turbulence measurements in Warm Core Rings reveal a pattern of intensity distribution that varies widely across a ring but the pattern is related to the physical regimes of a ring. In the high N (buoyancy frequency) region bounded by the 5 and 15 isotherms we found numerous patches up to 35 meters thick of intense turbulence as indicated by dissipation rates of up to 3×10^{-4} watts/cubic meter. The level of turbulence does not seem to depend on whether or not these isotherms are sloping, indicating that the energy source is not the geostrophic shear (which has a Richardson number too large to make it a source), but rather the shear associated with internal waves, probably inertial waves, and possibly the energy released by internal wave breaking for some of the thinner patches observed. The dissipation levels of up to 3×10^{-4} W/m^3 are comparable to the largest levels ever observed outside of mixing levels and comparable to levels observed in the equatorial undercurrent.

Title: CNOC Research Chair in Oceanography

Investigator: Christopher N.K. Mooers, Professor of Oceanography

Sponsor: Commander, Naval Oceanography Command

Objective: To promote the development of numerical ocean prediction, and to increase the interactions of the Oceanography Department with Fleet Numerical Oceanography Center.

Summary: Professor George L. Mellor, Princeton University, served in the Chair for the 1983 calendar year. He performed numerical modeling studies of coastal ocean circulation related to the California coastal regime, and of turbulent oceanic boundary layers. Prof. Mellor also provided much advice to students and faculty in their research.

Publications: Domoradskiz, J.A. and G.L. Mellor (1983) "A simple turbulence hypothesis for the triple velocity correlation functions in homogeneous, isotropic turbulence." Submitted to J. Fluid Mechanics.

Mellor, G.L. (1983) "Open Ocean boundary conditions for the shallow water wave equations". Submitted to Continental Shelf Research.

Mellor, G.L. and A.R. Blumburg (1983) "Modeling vertical and horizontal diffisivities and the sigma coordinate system." To be submitted.

Mellor, G.L. (1983) "The coastal upwelling boundary layer. To be submitted.

Title: Eddies in the California Current System

Investigator: Christopher N.K. Mooers, Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To determine the scientific requirements for practical forecasting of mesoscale ocean variability (eddies, fronts, and jets), and to increase our quantitative understanding of the kinematics, dynamics, and energetics of the eddies, fronts, and jets in the California Current System.

Summary: A series of real-time ocean forecasting experiments are being carried out off Northern California as part of the OPTOMA Program. The OPTOMA (Ocean Prediction Through Observation, Modeling, and Analysis) Program is a joint NPS/Harvard Project. The elements of the ocean descriptive/predictive system employed include an observing system and statistical and dynamical models. The observing system includes in situ measurements of the oceanic mass field in the upper ocean made from R/V ACANIA, R/V DE STEIGUER, and P-3's, and satellite remote sensing of sea surface temperature patterns using IR imagery. The instantaneous California Current System has been determined to consist of turublent jets meandering between counter-rotating synoptic/mesoscale eddies of ca. 100 km diameter. Frequently the jets entrain coastal waters, producing cool anomalies at and near the sea surface, which can have strong fronts along their boundaries. In addition to a series of exploratory and statistical/kinematical field studies, a prototype prediction experiment has been conducted in the summer of 1983, and another is planned for the summer of 1984. Two highly successful consecutive two-week forecasts were achieved during the month-long experiments in 1983. In 1984, forecasts will be made and verified over a two-month period. Further prediction experiments are planned over the next several years.

Publications:

Mooers, C.N.K. and Robinson, A.R., Turbulent Jets and Eddies in the California Current and Inferred Cross-Shore Transports (1984) Science, 223:51-53.

Robinson, A.R., J.A. Carton, C.N.K. Mooers, L.H. Walstad, E.F. Carter, M.M. Rienecker, J.A. Smith, and W.G. Leslie (1984) A Real Time, Dynamical Forecast of Ocean Synoptic/Mesoscale Eddies. NATURE (In press).

Thesis Directed: Durban, D.C. Analysis of Observed and Modeled Mixed Layers: NOCAL Region (1983) NPS Technical Report, NPS 68-83-005, 188pp.

Title:	Joint US/Australian Workshop on Wind-Driven Transient Continental Shelf Circulation
Investigator:	Christopher N.K. Mooers, Professor of Oceanography
Sponsor:	National Science Foundation
Objective:	To review the state of knowledge on wind-driven transient continental shelf circulation, and to promote the development of cooperative scientific efforts between Australian and US researchers in the topic area.
Summary:	A workshop was conducted at Asilomar Conference Center, 12 to 17 December 1982, with 57 participants and observers, 48 presentations, and several working groups.

Title: Support for Commander, Naval Oceanography Command MC & G and Hydrography Chair

Investigators: Christopher N. K. Mooers, Professor of Oceanography and Joseph J. Von Schwind Associate Professor of Oceanography and Geodetic Sciences

Sponsor: NAVNOC

Objective: To support the CNOC MC & G and Hydrography Chair

Summary: Dr. William Hart, Director, Bathymetry Division, Naval Oceanographic Office occupied the Chair for the year.

Theses Directed: M. R. Kenny and J. D. Mix, "Side Scan Sonar Target Detection in the Presence of Bottom Backscatter," Master Thesis, September 1983.

C. W. Schomaker, " A Model for Tidal Circulation Adapted to Monterey Bay, California," Master Thesis, September 1983.

Title: A Study of Correlations Between Optical and Temperature Structure Observed by Satellites and Subsurface Structure in a Persistent Coastal Upwelling Front

Investigator: James L. Mueller, Adjunct Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To characterize the space time correlations between optical and temperature variability associated with a persistent upwelling front, as observed by satellites, and the associated vertial structures in temperature and salinity, as well as ocean optical properties.

Summary: An ensemble of Coastal Zone Color Scanner (CZCS) images was analyzed using partitioned empirical orthogonal function methods to analyze the zonal structure in optical depth across the front, and the meridional variation in that structure. Two cruises of the R/V ACANIA were used to measure optical, biological and physical oceanographic profiles along cross shelf sections selected for analysis of correlations with variability observed in the satellite data.

Title: Horizontal Variability Effects on Optical Propagation in the Upper Ocean

Investigator: James L. Mueller, Adjunct Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To account for and test the effects of horizontal variability and advection in a model forecasting optical propagation in the upper ocean.

Summary: As part of the Office of Naval Research sponsored SRO project entitled "Environmental Effects on Optical Propagation," the present project contributes a study of the effects of horizontal variability on predictions of downward vector irradiance propagation. A major goal of the parent program is the development and testing of an irradiance propagation forecast model for the upper ocean in support of the Navy's performance evaluation of the proposed Strategic Laser Communications (SLC) system. A major expedition (42-days duration) was staged aboard the R/V ACANIA during the Optical Dynamics Experiment (ODEX) in October-November 1982. Primary efforts, during the balance of the year, were devoted to processing and analysis of the data acquired at the 185 oceanographic stations occupied by ACANIA during ODEX, and to processing and preliminary analysis of associated satellite data.

Conference Presentation: "Optical, physical, biological and chemical structures of the Mid-latitude NE Pacific Ocean during ODEX (October-November 1982)," XVIII General Assembly of the IUGG in Hamburg, West Germany, 18 August 1983.

Title: Applications of CZCS to Electro-Optical Propagation Analysis and Prediction in the Marine Boundary Layer

Investigators: James L. Mueller, Adjunct Professor of Oceanography, and Sasithorn Aranuvachapun, Adjunct Research Professor of Oceanography

Sponsor: NAVAIR/NEPRF

Objective: Develop and implement algorithms for using CZCS data to map aerosol distribution variations in support of electro-optical propagation forecasts for weapons systems.

Summary. An inherent byproduct of the CZCS atmospheric correction process is an image of "aerosol radiance" at a wavelength of 670 nm. "Aerosol radiance" is the fraction of radiance measured from space due to backscatter of solar radiation by atmospheric aerosols. Over space scales less than the meteorological synoptic scale, it is hypothesized that variations in aerosol radiance relate directly to variations in the concentration and/or size distribution of aerosols in the marine planetary boundary layer. Major activities during this period included determination of the decay in radiometric sensitivity of the CZCS over the first 20,000 orbits since Nimbus-7 was launched in 1978 (this proved to be an essential prerequisite to quantitative analysis of data from that sensor), and radiative transfer modelling of aerosol radiance using size distributions derived from aerosol measurements made available by another research project at NPS.

Title: Ocean Microstructure

Investigators: T. R. Osborn, Professor of Oceanography, and R. G. Lueck, Adjunct Research Professor of Oceanography

Sponsor: Office of Naval Research

Objective: Our goal is to describe and understand the mechanisms responsible for oceanic mixing and turbulence by using small scale velocity and temperature measurements to study turbulence in the ocean.

Summary: Turbulence measurements from the submarine USS DOLPHIN and vertical profiles are being analyzed. We are looking at salt finger signatures in frontal regions and near surface waters. Analysis shows the effect of stratification on the vertical velocity fluctuations.

Title: Expendable Dissipation Profiler

Investigator: T. R. Osborn, Professor of Oceanography

Sponsor: Naval Ocean Research and Development Activity

Objective: This research covers a continuation of the developmental work on the expendable dissipation profiler, aimed toward simplifying construction and operation and, at the same time make the probe more durable. Also, we are attempting to make the instrument available to a wide user community with a minimum of problems and frustrations.

Summary: The Expendable Dissipation Profiler (XDP) has been successfully sea tested in Monterey Canyon and the manufacturing facility has been moved to NPS from UBC. We have successfully tested the transportability of the XDP technology by giving 12 units to M. McPhee who deployed them in the Arctic Ocean in support of the MIZEX experiment and by giving 12 units to T. Sanford who deployed them in a cold core Gulf Stream ring.

Title: Shear Profiling

Investigators: T. R. Osborn, Professor of Oceanography, and R. G. Lueck, Adjunct Research Professor of Oceanography

Sponsor: Naval Ocean Research and Development Activity

Objective: A major question in ocean turbulence is the role of shear in generating and supporting small scale turbulent mixing in the ocean. Our objective is to measure oceanic shear throughout the water column by using a higher frequency doppler shear profiler operated from a stable platform in the water column.

Summary: A 1.2 Mhz doppler velocity profiler has been purchased and tested. Installation in the USS DOLPHIN is scheduled for April 1984 for 2 weeks of testing. Further measurements are scheduled for Oct-Nov 1984.

Title: Towed Body Turbulence Measurements

Investigators: T. R. Osborn, Professor of Oceanography, and R. G. Lueck, Adjunct Research Professor of Oceanography

Sponsor: Naval Ocean Research and Development Activity

Objective: The objective of this research is to develop a towed body that is capable of data acquisition for oceanic turbulence measurements.

Summary: A towed body has been successfully modified for oceanic measurements of turbulent parameters. Noise level for dissipation is 5×10^{-6} watts/m at a tow speed of 2 m/s. Data analysis and publication preparations are in progress.

tle: Chair in Arctic Marine Science

vestigators: Robert G. Paquette, Professor of Oceanography, and Miles G. McPhee, Visiting Professor of Oceanography

onsor: Office of Naval Research

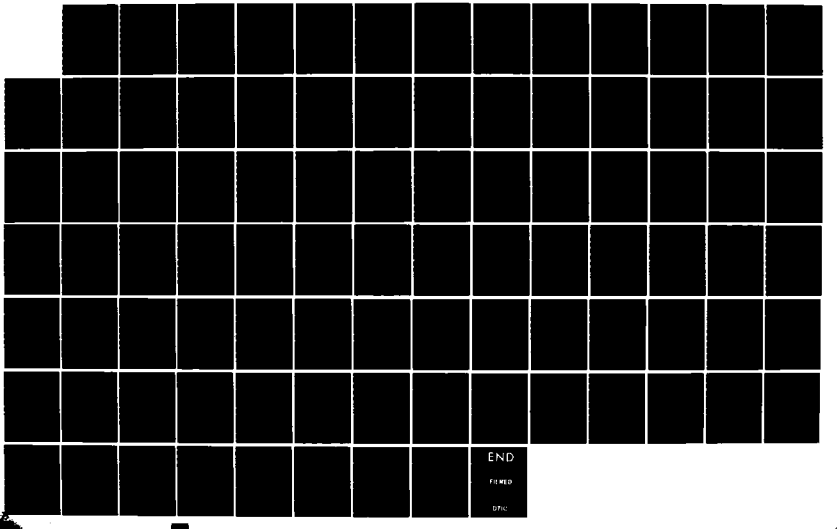
jectives: To foster oceanographic research in the Arctic, acquaint Naval officer students with Arctic problems, reduce results of pure research to practice, publicize Navy interest in the Arctic.

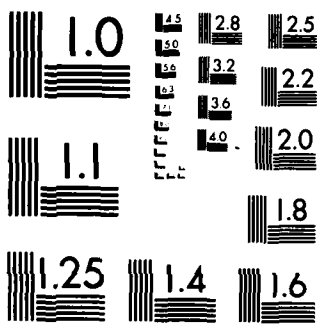
mmary: The writer is more of an administrator than a researcher in this task. However, some time was devoted to analysis of oceanographic data from the East Greenland Polar Front and preparation of a manuscript on Bering Sea researches.

Dr. McPhee was the U. S. Coordinator for the MIZEX Experiment in the Greenland Sea marginal ice zone, served as chief scientist on the station ship, carried out experiments to characterize the boundary layer under the ice and authored several reports and papers.

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Title: Marginal Sea-Ice Zone Studies 1983

Investigators: Robert G. Paquette, Professor of Oceanography, and Robert H. Bourke, Associate Professor of Oceanography

Sponsor: Arctic Submarine Laboratory

Objectives: Carry out physical oceanographic research, including field measurements, in the marginal sea-ice zone of the Bering, Chuckchi and Greenland Seas. This work has the long-term applied objective of facilitating the operation of submarines under ice. It is part of the continuing MIZPAC and MIZLANT programs.

Summary: This is an ongoing program to study the frontal and finestructure phenomena associated with the ice edges of the Atlantic and Pacific Oceans. Measurements, primarily CTD lowerings, have been carried out from ice breakers since 1971 and include observations both in summer and winter. During 1983 we completed the analysis and report of the 1980 winter cruise to the Bering Sea. The remainder of our time was spent analyzing the results of the October-November 1981 cruise to the East Greenland Polar Front (EGPF). Three topics have been examined intensively: (1) Characterization of the front and water mass interaction and its contrast to previous observations; (2) Circulation and transport studies based on dynamic topography; (3) Double diffusion processes related to the strong finestructure embedded in the front. Preparations were made for a cruise to the EGPF area but the cruise was cancelled at the last moment due to severe icing in the area. A student, LCDR Sleichter, is conducting acoustic propagation studies across the EGPF testing a variety of models for their applicability as part of his Master's Thesis.

Publications: R. H. Bourke, "Currents, fronts and fine structure in the marginal ice zone of the Chuckchi Sea," Polar Record, September 1983.

R. G. Paquette, R. H. Bourke and J. L. Newton, "Physical oceanography of the East Greenland Polar Front," In Progress.

R. H. Bourke, R. G. Paquette, and J. L. Newton, "Wintertime oceanographic conditions over the Bering Sea shelf," In Progress.

Conference Presentation:

J. L. Newton, R. H. Bourke, and R. G. Paquette, "Mesoscale structure of the East Greenland polar front," XVIII General Assembly of the International Union of Geology and Geophysics, Symposium on Sea Ice Modeling, Hamburg, West Germany, 18-19 August 1983.

Title: Nearshore Wave Properties

Investigator: Edward B. Thornton, Professor of Oceanography

Sponsor: Office of Naval Research

Objective: Basic studies are being made on the kinematics of breaking waves within the surf zone in the field. The specific objectives of the proposed research are: (1) determine breaking criterion as a function of depth, beach slope and wave frequency, and (2) determine the transformation of waves across the surf zone due to energy conversion and dissipation in the breaking process.

Summary: Research this past year emphasized the continued analysis of the results of the major field experiments at Torrey Pines, California and Santa Barbara, California, and the development of predictive models. A model describing the transformation of random wave heights was developed based on energy flux balance. Dissipation is considered due to wave breaking and bed friction. Wave breaking is characterized after periodic bores. The random nature of the wave heights is described starting with the Rayleigh distribution in deep water. The Rayleigh distribution is modified by wave breaking with an empirical transfer function. The modified distribution is itself the Rayleigh distribution. The model is compared both with laboratory results and an extensive set of field measurements collected at Torrey Pines Beach, California. The model is able to predict the increase in averaged wave height due to shoaling and subsequent decrease due to wave breaking. The model has only one adjustable parameter and is able to predict rms wave heights to within a standard error of 9.3% throughout the region from offshore to the beach.

Publications:

R. T. Guza and E. B. Thornton, "Wave set-up on a natural beach," Journal of Geophysical Research, 86, 4133-4137, 1981.

R. T. Guza and E. B. Thornton, "Swash oscillations on a natural beach," Journal of Geophysical Research, 87, 483-491, 1982.

D. A. Huntley, R. T. Guza and E. B. Thornton, "Field observations of surf beat: Part 1, progressive edge waves," Journal of Geophysical Research, 86, 6451-6466-1981.

E. B. Thornton and R. T. Guza, "Longshore currents and bed shear stress," Proceedings of the Directional Wave Spectra Applications, '81 Conference, ASCE, 147-164, 1981.

E. B. Thornton and R. T. Guza, "Energy saturation and phase speeds measured on a natural beach," Journal of Geophysical Research, 87, 9499-9508, 1982.

E. B. Thornton and R. T. Guza, "Transformation of wave height distribution," Journal of Geophysical Research, 88, 5925-5938, 1983.

R. T. Guza and E. B. Thornton, "Velocity moments in the nearshore," forthcoming in the J. Waterways, Harbours and Coastal Engineering.

E. B. Thornton and R. T. Guza, "Longshore currents generated by random waves," submitted to Journal of Geophysical Research.

Title:	Distribution of Spectral Irradiance of Natural Light Underwater
Investigator:	S. P. Tucker, Assistant Professor of Oceanography
Sponsor:	Naval Underwater Systems Center and DARPA
Objective:	To investigate the influence of non-optical ocean parameters on underwater irradiance and other optical properties in the Atlantic Ocean off the coast of Florida.
Summary:	This is part of a three-year project for which a final report is being prepared.
Publication:	Moore, C. A.; R. C. Honey; D. M. Hancock; S. Damron; R. Hilbers; and S. P. Tucker. "Instrumentation for Measuring Sea Truth for Laser Radar Applications". Ocean Optics VII Conference, Proceedings of the Society of Photo-Optical Instrumentation Engineers, Volume 489, June 1984.

Title:	Transparency of Near Shore Waters of the World's Oceans and Major Seas
Investigator:	S. P. Tucker, Assistant Professor of Oceanography
Sponsor:	Naval Ocean Research and Development Activity
Objective:	To prepare an atlas of the transparency of ocean waters less than 500 m in depth along the coastlines of the world between latitudes 40° N and 40° S.
Summary:	With co-investigators at NORDA we selected four charts to cover the world's coastlines between 40° N and 40° S at a scale of 1:12,233,000. Transparency (Secchi depth) was contoured on each of these charts for each of the four seasons for a total of sixteen charts. An additional four charts were prepared to reflect annual means. These charts are to be printed by the Defense Mapping Agency.
Publication:	Arnone, R. A.; S. P. Tucker; and F. A. Hilder. "Sec chi Depth Atlas of the World's Coastlines". Ocean Optics VII Conference, Proceedings of the Society of Photo-Optical Instrumentation Engineers, Vol. 489, June 1984.

DEPARTMENT

OF

MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

The research program in the Department of Mechanical Engineering has continued in several areas: applied mechanics; design and optimization; heat transfer; hydrodynamics and fluid mechanics; and materials science.

APPLIED MECHANICS

Professor Newton has continued his research on use of the finite element method to analyze the response of submerged structures to underwater shock waves. During the past two years he has collaborated with Professor R. T. Williams of the Meteorology Department on application of the finite element method to numerical weather prediction. This research is continuing.

Professor Cantin has continued his activities in computer aided engineering. The program GIFTS (Graphics Interactive Finite Element Time Sharing System) has been provided with an interface allowing the IBM version to execute on the duel screen graphics stations of the computer center. During the summer, a PRO/350 system was received on loan from the Digital Engineering Corp., to determine the feasibility of implementation of large codes on such a small machine. Several applications have been completed and the machine has been found capable to produce graphics of a sufficient quality to satisfy programs like GIFTS. The M.E. Lab for C.A.E. has also been equipped with an APOLLO DM300 work station which can accommodate most large codes. Work is in progress to prepare a PLOT-10 interface in order to take advantage of the graphics capabilities of the system.

Professor Shin has continued his research for DTNSRDC on developing acoustic damping measurement techniques and modal testing of propeller materials at low stress level, high frequency range, and various temperatures in a water environment. The measurement techniques include the impact hammer technique and the random excitation method. Extensive measurements of damping using both techniques were investigated and reported as part of a student Master's thesis. The modal testing laboratory was equipped with an HP-5451C Fourier analysis system, modal analysis module, zoom module, impact hammers, random exciter and spectrum analyzer. Professor Shin has also continued his research for the Defense Nuclear Agency on numerical and experimental studies of the underwater shock-induced responses of the submerged structures. As a part of the numerical studies, the EPSA (Elasto-Plastic Shell Analysis) code was interfaced with a PATRANG color graphics system to display the progressive responses of submerged structures. Underwater explosion tests are planned for FY84 using stiffened plate models.

DESIGN AND OPTIMIZATION

Professor Vanderplaats continued his work for NASA on the development of a library of FORTRAN programs for engineering design optimization using state-of-the-art techniques. A preliminary program, "ADS-1: A New General-Purpose Optimization Program" has been completed. This code contains over 100 possible combinations of algorithms available for optimization. In October, 1983, Dr. Noriaki Yoshida of Hokkaido Institute of Technology, Japan, joined in this effort as a research associate. Professor Vanderplaats continued distribution of his optimization program, COPES/CONMIN. An example of industrial application of this code was its use in optimal choice of experimental tests by an engine manufacturer, reducing the number of required test points by 75%. Other reported applications include stiffened composite panel optimization and the design of fan blades for an energy efficient engine. Professor Vanderplaats continued his investigations in structural optimization, probabilistic design, and application of optimization techniques to the design of machine components.

HEAT TRANSFER

Professor Marto has continued his investigation of heat transfer augmentation techniques which occur in two-phase heat exchange equipment such as boilers and condensers. This work has been carried out by several thesis students and by Adjunct Research Professor A. Wanniarachchi. The effect of condensate inundation upon heat transfer performance was examined with a five tube steam condenser apparatus. Data have been taken with both plain tubes and tubes containing a helical wire wrap. Results show that the presence of the wire decreases the effect of inundation dramatically. Work has continued under National Science Foundation sponsorship to experimentally determine enhanced condensation of steam on single horizontal tubes using finned tubes, new drainage techniques and the promotion of dropwise conditions. Professor Marto continued his experimental work with nucleate pool boiling from enhanced surfaces. A detailed study is being made on the performance characteristics of Gewa-T finned tubing during boiling of refrigerants.

Professor Garg together with Professor Marto started work on film condensation heat transfer on vertical fluted tubing. A finite difference program for the determination of film thickness on the tube has been developed. This program solves the boundary layer equations for the film in curvilinear coordinates, including surface tension effects. A finite-element solution for the two-dimensional conduction in the tube wall was also developed. Attempts are now being made to couple these solutions together to solve for heat transfer on a vertical fluted surface.

Professor Kelleher has recently begun a program to investigate natural convection heat transfer from a heated protrusion in a liquid filled enclosure. The motivation for this work stems from the stringent cooling requirements placed on modern microelectronic components. The reliability of modern electronic components is strongly dependent on the operating

temperature of the device. If the thermal control system is unable to carry away the heat generated and maintain the device temperature below acceptable levels the reliability of the component and hence the entire system will be seriously degraded. An efficient immersion cooling scheme requires a detailed knowledge of the natural convection process in liquid filled enclosures with walls having heat sources in the form of rectangular, block-like protrusions (the protrusions represent the common dual in line pin (DIP) packaging of electronic components). An experimental program to measure heat transfer rates and to visualize the flow in a rectangular enclosure with a single heated protrusion on one of the vertical walls is being conducted.

HYDRODYNAMICS AND FLUID MECHANICS

Professor Nunn has continued his investigations of jet-crossflow interactions. Experimental work has emphasized the use of liquid crystal thermography (LCT) to study the flow behavior near the surface in such interactions. Experiments conducted at the Royal Naval Engineering College (Plymouth, England) have led to useful insights regarding the nature and extent of regions where viscous effects dominate the surface flow and pressure distribution. Work has continued in modeling the jet-crossflow interaction with specific application to the prediction of the performance of ship bow thrusters. In a different area of study, LCT experiments are under development to examine the regions of secondary flow occuring near the surfaces of lifting bodies.

Professor Culbreth has constructed a flume for the study of jets and plumes in a cross-flowing ambient fluid using a laser Doppler Velocimeter (LDV). The LDV has been interfaced to an HP-9826 computer for data acquisition. Work has been completed on the determination of the length of the Zone of Flow Establishment for low Reynolds number jets and the current research involves the measurement of velocity profiles and entrainment in jets in cross-flow. An additional facility is being constructed to measure temperature distributions in buoyant jets through the use of a microthermocouple and the data acquisition system to determine the heat transfer behavior of jets.

Professor Kelleher has continued his study of the simplified boundary conditions for flows over flexible surfaces. The objective of the investigation is to determine the utility and range of validity of linearized boundary conditions in numerical investigations of flow over wavy surfaces. For this purpose, a copy of the spectral code for the analysis of the flow over wavy walls, developed by Cambridge Hydrodynamics, Inc., has been obtained. This code has been installed on the CYBER 170/175 computer at Fleet Numerical Oceanographic Center, Monterey. Presently, this code is being modified to incorporate the simplified boundary conditions. In the work completed to date, calculations have been made for flow over a stationary wavy wall using both linearized and nonlinear boundary conditions. Results in terms of surface pressure and surface shear have been obtained. Among other things, the results indicate that the use of linearized boundary conditions predicts separation at a lower wave amplitude than with the nonlinear boundary conditions.

Professor Sarpkaya continued the investigations of hydroelastic oscillations of cylinders and cables in steady and harmonic flow, discrete vortex numerical modeling of separated time-dependent flows, yaw and current effects on the flow past smooth and rough-walled cylinders, impulsively-started flow about bluff bodies, and the rise and demise of trailing vortices in stratified and unstratified fluids. The purpose of the harmonic flow studies is to develop an understanding of the vortex shedding about rigid and flexible bodies in order to minimize the consequences of hydroelastic oscillations and in order to determine the force-transfer coefficients for design purposes. The objective of the investigations on trailing vortices is to understand the various demise mechanisms to which a vortex is subjected (turbulent diffusion, vortex breakdown, and sinusoidal instability) and to develop means to precipitate the demise of such vortices in both unstratified and stratified fluid media. Extensive experiments and numerical analyses have been carried out on all these investigations with the dedicated help and assistance of the students working toward various degrees in Mechanical Engineering.

MATERIALS SCIENCE

Professor Challenger's research on both elevated temperature fatigue and high strength steel weldment development has continued. Numerous thesis students and Research Adjunct Professor Prabir Deb have contributed to the progress in the past year. It was shown that the HSLA steel NICOP could be successfully welded without preheating, making it a very promising replacement for HY-80 in many applications. HY-100 submerged-arc welds are presently under investigation to determine if acceptable fracture toughness can be maintained with high heat input welding conditions. Metallurgical characterization using the JEOL 120CX MXII TEM and fracture toughness using a newly developed single specimen elastic-plastic fracture toughness testing technique are being performed on welds made with different welding parameters. The high temperature fatigue facility is presently being used to study fatigue crack initiation of ferritic steels in oxidizing conditions. Also, a special stage for the scanning electron microscope has been constructed that will allow the complete fatigue test specimen to be examined. Beginning April 1984, Professor Challenger will be on temporary leave for two years from NPS, during which time he will be serving as a Liaison Scientist for the Office of Naval Research, London.

Professor McNelley has continued work on a project funded by the Naval Air Propulsion Center which is concerned with thermomechanical processing of M-50 steel. The processing is intended to refine the microstructure of M-50 prior to final hardening of the steel and such refinement has been demonstrated. In studies of the subsequent hardening response of the steel, this refinement has been shown to persist in the final structure, especially for lower hardening temperatures and shorter hardening times. It is proposed that such refinement will confer increased fatigue and spall resistance to this steel when employed in bearing applications. Current research is directed toward understanding the mechanism of refinement and its effect on the phase transformations in hardening of the steel and also toward evaluation of rolling-contact fatigue behavior of the steel. Also under the guidance of

Professor McNelley is an ongoing program with Naval Air Systems Command support which seeks to understand the effects of warm rolling to large deformations of Aluminum-Magnesium alloys containing up to 10 wt. pct. Mg. Such warm-rolled alloys develop ultra fine, sub-micron grain structures with fine intermetallic Al_8Mg_5 particles stabilizing the structure. Research has shown these materials to be strong and of good fatigue and corrosion resistance. Current research is directed at determining the superplastic flow characteristics of these alloys.

Professor Perkins' research cotinued on a National Science Foundation grant to investigate martensitic transformations in shape memory alloys. The main thrust of this research is to determine the mechanisms by which microstructural variables, such as grain size, dislocation substructure and vacancy concentration, affect the kinetics and morphology of the transformations. These questions are being approached mainly through the application of high-resolution transmission electron microscopic techniques. In this, the participation of Dr. Kenji Adachi as a research associate, has been invaluable.

Adjunct Research Professor Boone continued his work on hot corrosion of gas turbine blade materials. The influence of surface coatings and various metallic additions, such as platinum, upon hot corrosion performance has been experimentally studied. Platinum modified aluminide coatings were found to have several structural variations and these structures and their formation mechanisms were identified. These structural archtypes were fabricated and hot corrosion testing at both low (700°C) and high (850°C) temperatures were initiated.

Title:	Limits of Utility of Linearized Boundary Conditions for Flows Over Wavy Surfaces
Investigator:	M. D. Kelleher, Professor of Mechanical Engineering
Sponsor:	Naval Research Laboratory
Objective:	Conduct computational work to investigate the limits of utility of linearized boundary conditions in the computation of flow over wavy surfaces.
Summary:	An investigation has been conducted to determine the region of validity of linearized boundary conditions in the solution of the Navier-Stokes equations for flow over a wavy wall. Using a two-dimensional spectral code, calculations have been made for flow over a wavy wall, using both linearized and non-linear boundary conditions. Results in terms of surface pressure and surface shear are presented. Among other things, the results indicate that the use of linearized boundary conditions predicts separation at a lower wave amplitude than with the non-linear boundary conditions.

Title: Analysis of Film Condensation Heat Transfer on Vertical Fluted Tubing

Investigators: V. K. Garg, Adjunct Professor of Mechanical Engineering, and P. J. Marto, Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program

Objective: To analyze film condensation heat transfer upon vertically fluted tubing.

Summary: An analysis of film condensation on a vertical fluted tube has been made considering gravitational and surface tension effects over the entire fluted surface, and using surface-oriented coordinates. For the first time, surface tension effects are determined, as they should be, from the shape of the flute. Two-dimensional conduction within the condensate film, as well as in the fluted tube, is considered. A finite-difference solution of the highly non-linear partial differential equation for the film thickness is coupled with a finite-element solution of the conduction problem. The procedure has been tested on a sinusoidal flute with amplitude to pitch ratio $\sim$0.2. A linear extrapolation, on a log-log basis, of the results shows good comparison with experimental data.

Publications:

V. K. Garg and P. J. Marto, "Heat Transfer Due to Film Condensation on Vertical Fluted Tubes," NPS 69-84-003, June, 1984.

V. K. Garg and P. J. Marto, "Laminar Film Condensation on a Vertical Fluted Tube," Proceedings Third International Conference on Boundary and Interior Layers, Dublin, Ireland, June, 1984.

Title:	Experimental Investigation of the Fluid Mechanics of Buoyant Jets and Plumes
Investigator:	William G. Culbreth, Assistant Professor of Mechanical Engineering
Sponsor:	NPS Foundation Research Program
Objective:	To investigate the fluid mechanical and heat transfer properties of submerged buoyant jets. Velocity distributions are determined by Laser Doppler Velocimetry. Measurements are to be carried out for various crossflow to jet flow ratios and jet injection angles.
Summary:	A Laser Doppler Velocimeter has been interfaced to an HP-9826 computer and a three-dimensional transversing bed has been installed for the LDV. Software has been written that automatically transfers data from the LDV to the microcomputer and to the IBM 3033 via modem. Results have shown that the behavior of the length of the zone of flow establishment is a strong function of the jet nozzle Reynolds number and is not constant for non-buoyant jets, as previously assumed. Data has been acquired along the stream-wise axis of jets in crossflow.
Thesis Directed:	M. D. Wessman, "Measurement of Velocity Distributions in Turbulent Jets using Laser Doppler Velocimetry," Master's Thesis, June 1983.

tle: Development of a Testing Technique to Measure the Circumferential Yield Strength of Steel Cartridge Cases

vestigator: K. D. Challenger, Associate Professor of Mechanical Engineering.

onsor: Naval Weapons Support Station

jective: To develop a method to determine the yield strength in the circumferential direction of 5-inch steel cartridge cases and determine the effect of standard Navy sample preparation techniques on the actual yield strength of these cases.

ımmary: A hydraulically loaded method of expanding a segment of a cartridge case was developed and equipment designed and constructed. The actual yield strength of the cases was found to be 40% less than the "gysarent" yield strength measured by the currently used standard Navy methods. The main cause for the high gysarent yield strength produced by the standard Navy method is either precipitation hardening or relief of compressive residual stress that occurs during the 600°F stress required.

ıesis Directed: J. Blasko, "Yield Strength Determinations of 5-inch Steel Cartridge Cases," MSME, September 1983.

Title:	The Effect of Prestrain on the Fracture Toughness of HY-Series Steels
Investigator:	K. D. Challenger, Associate Professor of Mechanical Engineering
Sponsor:	David Taylor Ship Research and Development Activity
Objective:	To determine the mechanisms by which small amounts of plastic strain reduce the fracture toughness of HY-series steels.
Summary:	This is a continuation of a project initiated during the last half of FY82. Progress this year included a careful TEM study of the effect of plastic strain on dislocation-carbide precipitation interactions and the development of a model to predict the effect of prestrain on fracture resistance. The damage produced by small plastic strains is expected to be reversible by stress-relieving treatments as the mechanism of damage is a toughing of dislocations around carbides.
Publication:	K. D. Challenger, J. Mulligan and G. Sanford, "The Effect of Prestrain on Fracture Resistance - A Predictive Model," in Proceedings of the Conference, Fracture Prevention in Energy and Transport Systems, Rio de Janeiro, November 1983. (forthcoming).
Theses Directed:	J. Mulligan, "The Effect of Prestrain on the Fracture Toughness of HY-Series Steel Plates," Mechanical Engineer Degree, March 1983. G. Sanford, "The Effect of Prestrain on J_{IC} - A Predictive Model," MSME, June 1983.

Title:	Elevated Temperature Fatigue of Alloys used in Propulsion Systems
Investigator:	K. D. Challenger, Associate Professor of Mechanical Engineering
Sponsor:	David Taylor Ship Research and Development Activity
Objective:	To discover the damage mechanisms responsible for fatigue failures at elevated temperatures.
Summary:	The results generated last year while working at the Central Electric Research Laboratories, Leatherhead, England, have been further analyzed. It is clear now that in the absence of oxidation, fatigue crack growth will cease if compressive dwell periods are included in the cyclic wave form. However, in air, this same cyclic wave form accelerates fatigue crack growth due to an oxide cracking-regeneration mechanism. It has also been shown that oxide cracking alone will initiate a fatigue crack in the underlying metal surface.
Publications:	R. P. Skelton and K. D. Challenger, "Effects of Environment and Dwell During Fatigue Crack Growth in 2 1/4 Cr-1 Mo Steel at 525°C," submitted to Materials Science Engineers

Title: Characterization of High Strength Steel Weldments

Investigator: K. D. Challenger, Associate Professor of Mechanical Engineering

Sponsor: David Taylor Ship Research and Development Activity

Objective: Develop an Understanding of Microstructure-Fracture Relationships in High Strength Steel Weldments

Summary: The effect of preheating HY-80 and a HSLA steel, NICOP, on the resulting weldment microstructures was determined. Shielded metal arc weldments in 25mm thick plate were made using both a preheat of 120°C and precooling of 0°C (to simulate field repair under adverse conditions). The main reason preheating is used is to minimize hydrogen pick-up during welding as most high strength steels are suceptible to hydrogen assisted cracking, HAC. The susceptibility to HAC is dependent on the microstructure which is dependent on the welding conditions. The microstructures resulting from both welding conditions were carefully studied using transmission and scanning electron microscopy for both alloys. the NICOP microstructures should be resistant to HAC, but the HY-80 heat affected zone contains twinned martensite which is known to be susceptible to HAC, thus preheating may be required to minimize the hydrogen content of the weld.

Publications:

K. D. Challenger and B. J. Mason, "Comparison of Hydrogen Cracking Susceptibility of Cast and Rolled HY-130 Steel," Welding Journal, (forthcoming).

K. D. Challenger, R. B. Brucker, W. M. Elger and M. J. Sorek, 'Microstructure-Thermal History Correlations for Thick Section HY-130 Steel Weldments," Welding Journal, (under review).

Theses Directed:

D. R. Clark, "The Effect of Preheat on HY-80 SMAW Welds, " MSME, September 1983.

R. Burna, "The Effect of Preheat on NICOP Steel Weldments," MSME, September 1983.

Title: Research Activities at AMMRC

Investigator: Gilles Cantin

Sponsor: Army Materials and Mechanics Research Center,

Objective: To improve C.A.E. (Computer Aided Engineering) activities at AMMRC

Summary: GIFTS (Graphics Interactive Finite Element Time Sharing System) was installed in a UNIVAC computer at Natick, Mass. The computer is accessible from the Lab at Watertown through telephone lines. During the first two weeks when the system was being installed, arrangements had been made to use the NPS computer over AUTOVON lines in the morning before the beginning of the school day in Monterey. Several seminars were given to the AMMRC staff. Formal class instruction was given to a group of Engineers and Scientists (7-10) once a week on Computer Aided Engineering. Daily one-on-one assistance was given to six Engineers involved on various computational projects for the Army.

Title:	C. A. E. (Computer Aided Engineering with a DEC (Digital Engineering Corporation) PRO/350 Personal Micro-Computer.
Investigator:	Gilles Cantin
Sponsor:	None
Objective:	Determine the feasibility of implementation of C.A.E. systems on the PRO/350. Targetted systems are: CAL/NPS and GIFTS.
Summary:	An elaborate package of software called a Tool Kit by DEC was installed on the VAX/780 of the Computer Science department. This package allows to develop applications for the PRO/350 in the VAX/780; the applications are then down loaded from the VAX/780 for usage in the PRO/350. Several equipment failures were corrected by DEC during the period from June 1983 and three different versions of the operating system were used with the PRO. Small applications have been developed successfully. The project is continuing.

Title:	C.A.E. (Computer Aided Engineering) with an APOLLO Computer
Investigator:	Gilles Cantin, Professor of Mechanical Engineering
Sponsor:	NPS Research Foundation 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:	The system was delivered late in December 1983. Its usage will be covered in next year's activity report. However, it can already be said that CAL/NPS has been installed and is working. The GIFTS system installation will require GRAPHICS interface, but this is well under way.

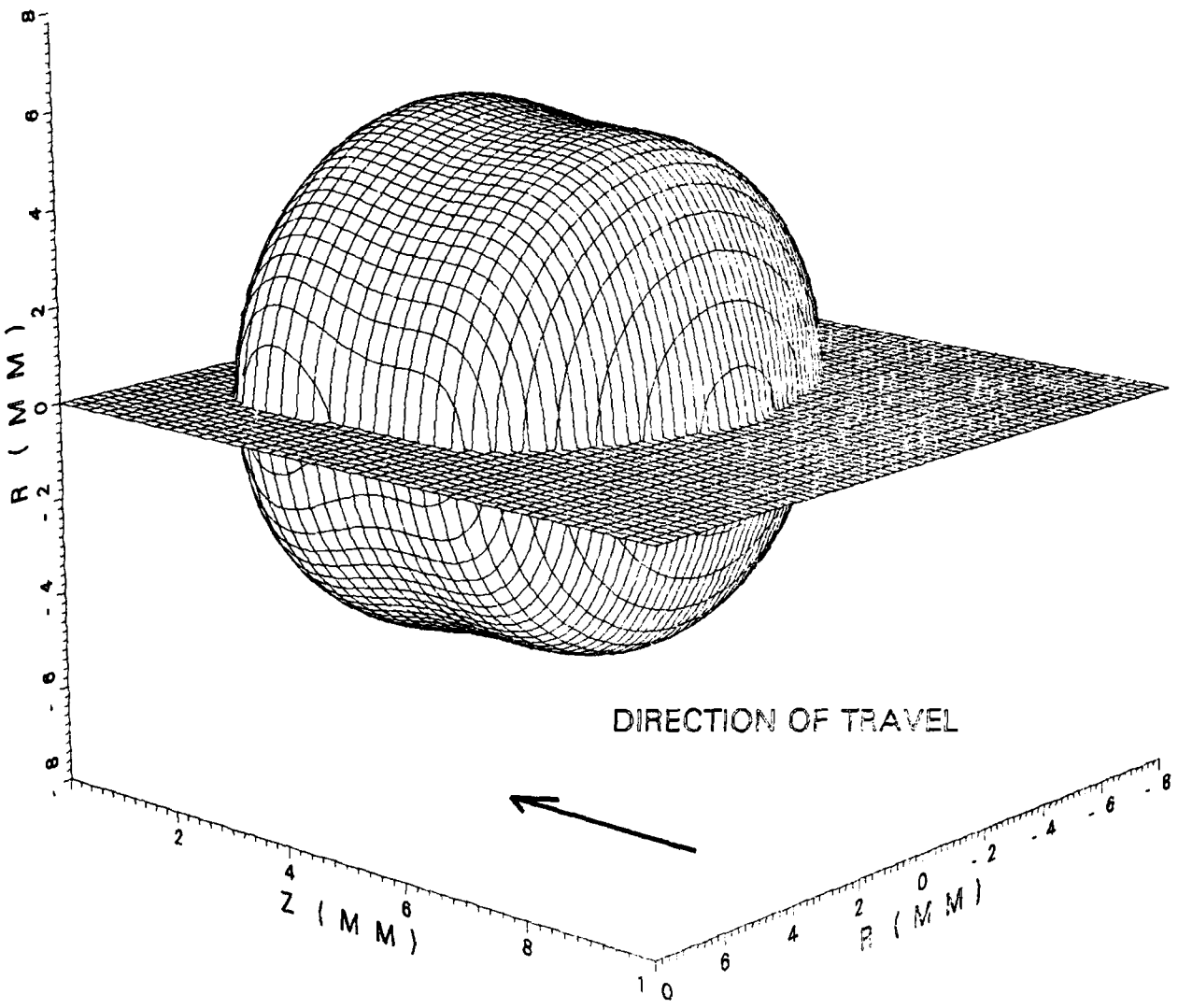
Title:	Surface Effects On Plasma Spray Coating Protectivity
Investigator:	Donald H. Boone, Adjunct Research Professor
Sponsor:	NPS Foundation Research Program
Objective:	To understand the effect of post coating processing treatments on the protective oxide formation and adherence formed on plasma spray applied coatings.
Summary:	An active element effect as characterized by the presence of oxide 'pegs' was identified for the Hf containing CoCrAl coating. Post coating operations and their sequence of application were found to influence oxide adherence for the active element containing coating. Surface polishing followed by a peening operation was found to be the most beneficial. No effect of post coating processing operation was found for the active element free coating. Further studies are planned to evaluate these effects in hot corrosion testing.

Title:	The Substrate Effect In Low Temperature Hot Corrosion Resistant Coatings
Investigator:	Donald H. Boone, Adjunct Research Professor
Sponsor:	NAVSEA
Objective:	To understand the influence of substrate and coating substrate inner layers, such as platinum, on the hot corrosion resistance of CoCrAlY overlay coatings.
Summary:	A strong substrate effect was identified on the low temperature hot corrosion resistance of the CoCrAlY type coatings. Pretesting thermal exposure was found to have either a beneficial or detrimental effect on the corrosion resistance, compared with the unexposed and tested samples confirming the strong influence of selected substrate elements diffusing through the coating. The role of a platinum inner layer is postulated to be a diffusion barrier, selectively interacting with critical substrate elements.

Title:	Structure and Performance of Al_2O_3 Scales Formed on Noble Metal Containing Aluminides.
Investigator:	Donald H. Boone, Adjunct Research Professor
Sponsor:	Office of Naval Research
Objective:	To understand the effects of noble metal additions to aluminide coatings, their structure, processing, and protectivity in high temperature hot corrosion and cyclic oxidation conditions.
Summary:	A range of coating structures varying from single phase $PtAL_2$ through a two-phase $PtAl_2$-β(NiPi-Al) to the single phase β(NiPtAl) were found to exist in commercial coatings and procedures for producing these structures were established. Surface topology of the resulting coatings was found to be related to the selective interdiffusion of the Pt with the superalloy substrate. The effect of this rough surface on resulting oxide formation and adherence is under investigation. Hot corrosion testing of the various structures is in progress on 700° and 900°.

DROPLET PROFILE

NORMALIZED DROPLET HEIGHT = 18.07



One centimeter diameter oil droplet rising through water in a direct-contact liquid-liquid heat exchanger.

Title:	Thermal Performance of the Upgraded Logic Module (ULM)
Investigator:	M. D. Kelleher, Professor of Mechanical Engineering
Sponsor	U. S. Army Combat Developments Experimental Command
Objective:	Analyze the thermal performance of the U.S. Army's new Upgraded Logic Module and run experiments to monitor the thermal performance.
Summary:	The U. S. Army has developed an Upgraded Logic Module (ULM) for use in its Infantry Direct Fire Simulator System (IDFSS). It is designed to analyze data collected from associated instrumentation according to prescribed programming , to report results back to the system control via a telemetry interface, and it can be backpack-mounted. The thermal environment existing at Ft. Hunter Liggett, CA (the primary operating environment for the ULM) during the summer will add an abnormal thermal load to the ULM operating environment in the backpack. A mock-up of the actual ULM was built to model the heat dissipation of all the components and tested in different environments, using extreme power consumption rates. The actual ULM was tested with typical power consumption rates and various environmental temperature, including solar loading. Under typical operating conditions, the ULM will remain within manufacturer's tolerances for individual component temperatures. However, slight increases in power consumption rates will severely stress the reliability limits of certain components, and the reliability of the entire system cannot be predicted.
Thesis Directed:	Henry C. Keebler III, Capt., USA, "Analysis and Testing of the Thermal Design of the Electronic Package in the U. S. Army's Upgraded Logic Module (ULM," Thesis for Master of Science in Mechanical Engineering, September 1983.

Title:	Determination of the Influence of Processing History on the Carbon Content of the Martensite in a High-Carbon Bearing Steel by X-ray Diffraction
Investigators:	T. R. McNelley, Associate Professor of Mechanical Engineering and A. Garg, Adjunct Research Professor of Mechanical Engineering
Sponsor:	NPS Research Foundation Program
Objective:	Development of an X-ray technique, based on separation of diffracting peaks into doublets as a result of tetragonality, to determine the carbon content of the martensite in a high-carbon bearing steel and application of the method to evaluate the effect of the processing history of the steel.
Summary:	Conventional, as-received AISI 52100 steel and the same material subjected to a grain-refining thermomechanical treatment were studied in this program. Samples from both were austenitized over a series of temperatures ranging from 820°C to 1,000°C. X-ray diffraction patterns were obtained with particular attention given to recording the {200} doublet. The data was analyzed by fitting the doublet with a Pearson VII type function which assumes the doublet to be made up of two overlapping symmetrical peaks, one for the (200), (020) pair and one for (002). When the individual peak positions were known, the carbon content of the martensite could be determined by measuring the angular difference in peak position, $\Delta\theta$ and then using data in the literature relating carbon content of martensite to lattice spacing and hence to diffraction peak positions. The data so obtained was shown to be identical to carbon content determination by the more tedious carbide extraction replica method.
Thesis Directed:	E. V. Bres, "The Heat Treatment Response of Thermomechanically Processed M-50 Steel", Masters Thesis, December 1983.
Paper Submitted:	T. R. McNelley and A. Garg, "Determination of the Effect of Austenitizing Temperature on Carbon Content of Martensite in AISI 52100 Steel by X-ray Diffraction", submitted to Journal of Heat Treating

Title: High-Strength Aluminum-Magnesium Alloys: Thermo-mechanical Processing, Microstructure and Mechanical Properties

Investigator: T. R. McNelley, Associate Professor of Mechanical Engineering

Sponsor: Naval Air Systems Command

Objective: To study the microstructures developed by thermomechanical processing of high-Mg, Al-Mg alloys and to establish microstructure-mechanical property relationships in these alloys.

Summary: Transmission electron microscopy (TEM) has been applied to determine the size and distribution of precipitated intermetallic β (Al_8Mg_5) as well as the size of subgrains formed in warm rolling of these alloys. Also, the size, distribution and amount of the ternary precipitates in both Cu- and Mn- bearing Al-Mg alloys have also been identified and characterized. The most significant observation made, however, was in the area of grain size control. Annealing after warm rolling may be used to obtain recrystallization to very fine microstructures. To attain fine structures it is necessary to anneal below the solvus for Mg; here, the presence of the intermetallic β prevents growth of recrystallizing grains and it is readily possible to produce a grain size below 1.0μm, stabilized by intermetallic β of size 0.1 - 0.3μm. The β here is uniformly distributed as a result of the warm rolling. Conventional cold work - anneal cycles would lead to precipitation of Mg on slip bands and in grain boundaries and hence a less uniform distribution of the β. This, in turn, would be expected to provide a less refined recrystallized grain structure.

Mechanical property studies in the past year have focused on measurement of fatigue crack growth (FCG) rates in a series of alloys. In two cases, a binary Al-Mg alloy and a Cu-bearing alloy, FCG rates were improved relative to those measured in 7075-T6, selected for comparison. A Mn-bearing alloy was also evaluated and found to have very poor FCG resistance and overall a poor fracture toughness. This is thought to result from the presence of Mn Al_6 precipitates in grain and sub-

grain boundaries and a large volume fraction of coarse β. The latter may result from incomplete solutioning of the Mg due to the presence of Mn.

Publications:

A. Garg and T. R. McNelley, "The Development of Substructures by Thermomechanical Processing of an Al-10 Pct. Mg Alloy," submitted to Scripta Metallurgica.

T. R. McNelley, "The Mechanical Properties of Thermomechanically Processed High-Magnesium Aluminum-Magnesium Alloys," submitted to Naval Air Systems Command for review prior to circulation.

Thesis Directed:

K. D. Oberhofer, "Fatigue Crack Growth Rates of High-Magnesium Aluminum-Magnesium Alloys as Influenced by Solution Treatment Time and Alloy Content," Master's Thesis, June 1983.

Title: Application of a Thermomechanical Process for Refinement of Grain and Carbide Size to M-50 Steel

Investigator: T. R. McNelley, Associate Professor of Mechanical Engineering

Sponsor: Naval Air Propulsion Center

Objective: Application of a thermomechanical processing method to process material of diameter sufficient to fabricate RC (Rolling Contact) test samples. Work in progress on characterization of material already processed on a smaller scale will continue, to assess the value of the thermomechanical treatment with regard to potential application to M-50 bearings.

Summary: During the past year, the thermomechanical processing method originally proposed has been applied successfully (1) to laboratory warm rolling of M-50 steel. The processing method is essentially that applied (2) to another bearing steel, AISI 52100, the central feature of its processing is warm rolling, to large strains at warm temperatures and the objective is to produce highly refined grains, of size below 1.0μm with refined carbides as well (3-5). The carbides in M-50 are more complex as the steel itself is more heavily alloyed (6,7). As such, some transition metal carbides (Mo_2C ,VC) were not dissolved in the initial stages of processing and hence were less refined in subsequent warm rolling. Nonetheless, the carbide precipitated from solution during rolling were refined to a size of 0.1 - 0.2μm and the residual, undissolved carbides were reduced from 30 μm in as-received material to 12 μm or less in rolled material.

Scaling up of the processing is in progress as of this writing. Thus far, bar has been rolled to a final diameter of 0.3 inch (7.6 mm) and material to yield still larger bar is being processed. In addition, study of the heat treatment response of the processed material is being conducted and some exciting results obtained.

Publication: T. R. McNelley, M. R. Edwards, A. Doig, D. H. Boone, and C. W. Schultz, "The Effect of Prior Heat Treatments on the Structure and Properties of Warm-Rolled AISI 52100 Steel," Metallurgical

Transactions A, Vol. 14A, (1983), pp. 1427-1434.

Thesis Directed: K. R. Larson, "Thermomechanical Processing of M-50 Bearing Steel," Master's Thesis, June 1983.

Title: Condenser Heat Transfer Augmentation

Investigators: P. J. Marto, Professor and Chairman of Mechanical Engineering, and R. H. Nunn, Professor of Mechanical Engineering

Sponsor: David W. Taylor Naval Ship Research and Development Center

Objective: To develop a comprehensive computer model to analyze the improvement which enhanced heat transfer tubing can make upon Naval condensers.

Summary: A one-dimensional computer code was utilized to assess the benefits of using various heat transfer enhancement schemes. Based upon the results obtained, it has been shown that the use of enhanced tubes can lead to considerable reductions in condenser volume and weight. Several enhanced tubing geometries were chosen to be tested in a small bundle apparatus to determine the effect of condensate inundation upon steam-side performance. Results show that a wire wrap around the condenser tube can effectively reduce the deteriorating effect of condensate inundation.

Publications:

P. J. Marto, and R. H. Nunn, "The Potential of Heat Transfer Enhancement in Surface Condensers," I. Chem. E. Symposium Series No. 75, Condensers: Theory and Practice, Pergamon Press, 1983.

P. J. Marto, "Heat Transfer and Two-Phase Flow During Shell-side Condensation," ASME-JSME Thermal Engineering Joint Conference, Vol. 2, 1983, pp. 561-591.

P. J. Marto, "Improving the Thermal Performance of Large Condenser Tube Bundles," EPRI Symposium on State-of-the-Art Condenser Technology, I. Diaz-Tous and R. J. Bell (Editors), Orlando, June, 1983.

Conference Presentations:

P. J. Marto, and R. H. Nunn, "The Potential of Heat Transfer Enhancement in Surface Condensers," International Conference on Surface Condensers: Theory and Practice, Manchester, U. K., March 1983.

P. J. Marto, Heat Transfer and Two-Phase Flow

During Shell-side Condensation," ASME-JSME Thermal Engineering Joint Conference, Honolulu, Hawaii, March 1983.

P. J. Marto, "Improving the Thermal Performance of Large Condenser Tube Bundles," EPRI Symposium on State-of-the-Art Condenser Technology, Orlando, FL, June 1983.

Thesis Directed:

G. D. Kanakis, "The Effect of Condensate Inundation on Steam Condensation Heat Transfer to Wire-Wrapped Tubing," Master's Thesis, June 1983.

Title: Nucleate Pool Boiling Characteristics of a GEWA-T Finned Surface

Investigator: P. J. Marto, Professor and Chairman of Mechanical Engineering

Sponsor: None

Objective: To experimentally ascertain the important heat transfer mechanisms which occur during nucleate pool boiling from a GEWA-T finned surface.

Summary: A series of measurements were made with a 50mm long, 22mm OD solid copper cylinder whose outer surface was finned into a GEWA-T profile as manufactured by Wieland-Werke, AG. The cylinder was bored out to accommodate a cartridge heater, having a thick annular wall in which eight copper-constantan thermocouples were soldered. Data were taken with Freon-113 at atmospheric pressure. Results show that this surface can enhance nucleate pool boiling heat transfer coefficients by over 300 percent.

Publications: P. J. Marto and V. J. Lepere, "Pool Boiling Heat Transfer From Enhanced Surfaces to Dielectric Fluids," Journal of Heat Transfer, Vol. 104, No. 2, (May 1982), pp. 292-299.

P. J. Marto and B. Hernandez, "Nucleate Pool Boiling Characteristics of a GEWA-T Surface in Freon-113," AIChE Symposium Series, Vol. 79, No. 225, (1983), pp. 1-10.

Thesis Directed: B. G. Hernandez, Jr., "An Experimental Study of Nucleate Pool Boiling Heat Transfer from a GEWA-T Finned Surface in Freon-113," Master's Thesis, December 1982.

Title:	NAVSEA Research Chair Professorship
Investigator:	P. J. Marto, Professor of Mechanical Engineering
Sponsor:	Naval Sea Systems Command
Objective:	The purpose of this research program is to allow outstanding individuals from universities, industry or government to visit NPS to perform research of interest to the Naval Sea Systems Command.
Summary:	During FY 83, the position of NAVSEA Research Chair Professor was unfilled. During FY84, Dr. Walter D. Pilkey, University of Virginia, will be appointed to the chair position. Dr. Pilkey, a leading expert in the field of applied mechanics, will utilize his expertise to study the dynamic response of shipboard structural members.

Title: Enhanced Condensation of Steam on Horizontal Tubes

Investigator: P. J. Marto, Professor and Chairman of Mechanical Engineering

Sponsor: National Science Foundation

Objective: To experimentally determine the influence of various enhancement techniques upon steam condensation heat transfer coefficients on a single horizontal tube.

Summary: A single tube apparatus was designed and constructed to reliably measure steam condensation heat transfer coefficients. The apparatus was constructed of stainless steel and glass to avoid contamination problems and to facilitate cleaning. A thick-walled, smooth copper tube was instrumented with six wall thermocouples to measure outside and inside coefficients. Data were taken at various steam velocities and were compared to data taken using finned tubes. The six finned tubes were manufactured with a fin height and thickness of 1 mm but with variable fin spacings. The data show that an optimum fin spacing of 2.0 mm gives an enhancement of 3-4 over the smooth tube case. A steam endurance test apparatus was also built to test a variety of dropwise coatings on 25 mm square specimens. Several promising coatings have been discovered.

Thesis Directed: K. A. Graber, "Condensation Heat Transfer of Steam on a Single Horizontal Tube," Master's Thesis, June 1983.

Title:	Jets in Crossflow with Ship Bow Thruster Applications
Investigator:	R. H. Nunn, Professor of Mechanical Engineering
Sponsor:	None
Objective:	Develop verified analytical model for the surface pressure distribution surrounding the jet in crossflow.
Summary:	This program has led to a semi-empirical model for the strength of the contra-rotating vortex pair that characterizes a jet in crossflow. In addition, liquid crystal thermographic studies have been conducted to further define the viscous region of the overall interaction. Present efforts are directed towards application of the above to surface pressure field predictions.
Publications:	R. H. Nunn, "Vorticity Growth and Decay in the Jet in Crossflow," AIAA Journal, (forthcoming).
Thesis Directed:	D. F. Linsell, "Liquid Crystal Thermography for Visualization of Surface Effects of Fluid Jets in Crossflow," MSC, Royal Naval Engineering College, July 1983.

Title: Martensitic Transformations in Shape Memory Alloys

Investigator: Jeff Perkins, Associate Professor of Mechanical Engineering

Sponsor: National Science Foundation

Objective: The general objective of the research is to examine the effect of microstructural parameters on martensitic transformation in shape memory alloys.

Summary: Considerable progress has been made in the examination of the effects of microstructural variables, including grain size and dislocation substructure. Effects of transformation kinetics have also been studied in detail.

Publications:

Jeff Perkins, "Rapid Solidification Effects in Martensitic Cu-Zn-Al Alloys," Metallurgical Transactions 13A(1982), pp. 1367-1372.

Jeff Perkins and W. E. Muesing, "Martensitic Transformation Cycling Effects in Cu-Zn-Al Shape Memory Alloys," Metallurgical Transactions, 13A(1983), pp. 33-36.

Jeff Perkins, "The Microstructure of Rapidly Solidified β-Phase Cu-Zn-Al Alloys," Metallurgical Transactions, 14A(1983)

Jeff Perkins and R. O. Spanholz, "Stress-Induced Martensitic Transformation Cycling and Two-Way Shape Memory 'Training' in Cu-Zn-Al Alloys," Metallurgical Transactions, (forthcoming).

Conference Presentations:

Jeff Perkins, "Effects of Austenite Microstructure on Martensitic Transformations in Cu-Zn-Al Shape Memory Alloys," International Conference on Martensite Transformations, Leuven, Belgium, August 1982.

Jeff Perkins, "Transformation Cycling Effects in Martensitic Cu-Zn-Al Shape Memory Alloys," Fall 1982 Meeting of the Metallurgical Society, St. Louis, MO, October 1982.

Jeff Perkins, "Martensitic Transformation Cycling

and the Phenomenon of Two-Way Shape Memory Training," International Conference on Phase Transformations in Solids, Charia, Crete, Greece, June 1983.

Title: Development of a Library of Numerical Optimization Programs for Engineering Design

Investigator: Garret N. Vanderplaats, Associate Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program

Objective: To develop a library of FORTRAN programs for engineering design optimization using state-of-the-art techniques.

Summary: The FORTRAN program was completed and initial testing was done. A preliminary version of the code was delivered to the principal sponsor. Dr. H. Sugimoto was employed for one year as a senior research associate to aid in program development and checkout.

The final version of the program, together with documentation, is expected to be delivered to the NASA sponsor in early 1984, with work in the area of optimum sensitivity continuing for the remainder of FY84.

Publications;

Vanderplaats, G.N., Sugimoto, H., and Sprague, C.M., "ADS-1: A General-Purpose Optimization Program", Proc. 24th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics and Materials Conference, Lake Tahoe, Nevada, May 1983. (Accepted for publication, AIAA Journal).

Vanderplaats, G.N., "A Robust Feasible Direction Algorithm for Design Synthesis", Proc. 24th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics and Materials Conference, Lake Tahoe, Nevada, May 1983. (Accepted for publication, AIAA Journal).

Vanderplaats, G.N., "The ADS General-Purpose Optimization Program", Proc. Symposium on Recent Experiences in Multidisciplinary Analysis and Optimization, NASA Langley Research Center, Hampton, VA, April 24 - 26, 1984.

Vanderplaats, G.N. and Yoshida, N., "Efficient Calculation Optimum Design Sensitivity", Proc. 25th AIAA/ASME/ASCE/AHS Structural Dynamics and Materials Conference, Palm Springs, CA, May 14 - 16, 1984.

is Directed: R. W. Lukins, "Probabilistic Fatigue Life Predictions of Structural Components in High-Cycle Fatigue Regimes," Master's Thesis, June 1983.

Title: Reliability-based Analysis of Random High Cycle Fatigue Life.

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

Sponsor: NPS Foundation Research Program

Objective: To develop the reliability-based analysis method of high-cycle fatigue life under the random vibration environments, and to develop a related computer program to evaluate the fatigue life as a probability of survival.

Summary: The collection of test results shows that a Weibull distribution function is found to be a best probability model for the critical fatigue damage index. The analytical equations were formulated. A compute program, "FATIGUE," was developed and is in operational in IBM computer. Parametric studies were performed to evaluate the sensitive parameters to fatigue life. The need to develop a fatigue life prediction for the multi-axial state of stress was identified and the efforts have been made to look into the details of fatigue failure criterion.

Publication: Y. S. Shin and R. W. Lukins, "Probability-based High-cycle Fatigue Life Predictions," Submitted for the publication in ASME Journal of Pressure Vessel Technology.

Conference Presentation: Y. S. Shin and R. W. Lukins, "Reliability-based Fatigue Damage Predictions under Random Vibration Environment," Presented at the AIAA/ASME/ASCE/AHS 24th Structures, Structural Dynamics, and Materials Conference in Lake Tahoe, Nevada, May 2-4, 1983.

Y. S. Shin and R. W. Lukins, "Probability-based High-cycle Fatigue Life Predictions," Presented at the ASME 4th National Congress on Pressure Vessel and Piping Conference in Portland, Oregon,June 19-24, 1983.

hesis Directed: Four students are working in this area for their Master's thesis.

Title: Numerical and Experimental Studies of Non-Linear Transient Dynamic Responses Submerged Structures under Shock and Vibration Environments.

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

Sponsor: NPS Foundation Research Program

Objective: (1) To look into the insight of the large deflection elastic-plastic transient response characteristics of submerged ductile structures in the vibro-acoustic shock loading condition, and (2) to develop experimental correlations among the shock source intensities, near- and far-field acoustic pressures and the corresponding structural responses, and also to validate the predicted result with that of the experiments.

Summary: The state-of-the-art technology review was performed and the various numerical methods for the shock response analysis of the submerged structures were evaluated. The conceptual studies of non-linear transient response analysis subjected to underwater shock are in progress. PATRANG interactive color graphics program was installed in NPS VAX computer and Ramtek 6211 graphics terminal was installed, and both are in operational. The extensive pre- and post-processing capabilities have been developed in color modes that facilitate the complex response phenomena easier to understand.

HP-5451C Fast Fourier Transform Analysis System was acquired and installed in Bldg. 500. The system is in full operation since May, 1983.

Publication: Y. S. Shin and M. K. Chargin, "Acoustic Responses of Coupled Fluid-Structure System by Acoustic-Structural Analogy," The Shock and Vibration Bulletin, May 1983.

Conference Presentation: Y. S. Shin and F. Daube, "Underwater Shock-Induced Responses of Submerged Cylindrical Shell," Submitted for the presentation at Symposium on Flow-Induced Vibration at the 1984 ASME Winter Annual Meeting, New Orleans, Louisiana, December 9-13, 1984.

Title: Acoustic Damping Measurement and Modal Testing Conducted at Low Stress Level and High Frequency Range with Temperature Variations.

Investigators: Y. S. Shin and A. J. Perkins, Associate Professors of Mechanical Engineering

Sponsor: David Taylor Naval Ship R&D Center

Objective: To design a test procedure that allows the measurement of acoustic damping in a plate specimen at low stress with the following variables: (1) plate specimen: (40"x14"x1") and (40"x14:x2"); (2) acoustic frequency range of 100 through 20,000 Hz, and (3) temperature range of -5° through 15°C in water environment.

Summary: The U. S. Navy has been developing new high damping propeller materials for the ship and submarine silencing applications. The measurement technique and test procedure for the acoustic damping have been developed and under investigation with the objective outlined above. The measurement techniques include impact hammer technique and random excitation method. The test chamber was built to accommodate a large plate specimen in the water environment with temperature control. The extensive measurement of damping using the impact hammer was investigated and reported the results as a part of student Master's thesis. As an initial phase of the work, the conventional propeller materials are used to develop the measurement technique and sensitive studies.

Thesis Directed: R. A. Heidgerken, "The Design of a Test Procedure for the Measurement of Acoustic Damping of Materials at Low Stress," Master's Thesis, September 1983.

Flow," Master's Thesis, June 1983.

M. Maixner, "Discrete Vortex Analysis of Harmonically Oscillating Flow about Cylinders," Ph. D. Thesis in progress.

Title: Yaw and Current Effects on Hydrodynamic Resistance of Cylinders

Investigator: T. Sarpkaya, Distinguished Professor of Mechanical Engineering

Sponsor: National Science Foundation

Objective: To determine the lift, drag, and inertia coefficients for smooth and rough circular cylinders in yaw and current in a harmonically oscillating flow and to carry out a discrete vortex analysis of the separated time-dependent flow.

Summary: Experiments have been carried out with smooth and sand-roughened circular cylinders in harmonically oscillating flow in a large U-shaped water tunnel The force transfer coefficients have been determined for various angles of yaw. The results have shown that the flow about each cylinder is unique and the independence principle (cosine law) does not hold true over the range of Reynolds numbers and Keulegan-Carpenter numbers investigated. Furthermore, the pressure distribution has been measured about smooth and rough cylinders and the results have been related to the evolution of the vortices. The discrete vortex model has been considerably improved and the analytical predictions of the behavior of impulsively started flow have been shown to be in excellent agreement with those obtained experimentally. Additional work is underway to extend the analysis to harmonically oscillating flows.

Publications: T. Sarpkaya and I. Cakal, "A Comprehensive Sensitivity Analysis of the OTS Data," Proceedings of the Offshore Technology Conference Vol. 1, (1983), pp. 317-326.

T. Sarpkaya, "Oscillating Flow About Yawed Cylinders," Technical Report, NPS-69-83-001, March 1983.

Theses Directed: I. Cakal, "Sensitivity Analysis of an Ocean Test Data," Master's Thesis, December 1982.

John R. Wilson, "Pressure Distribution on Smooth and Rough Cylinders in Harmonically Oscillating

Dan Simons, "Trailing Vortices of Axisymmetric Bodies in Homogeneous and Density-Stratified Media," Master's Thesis, June 1983.

Title:	Trailing Vortices in Stratified Medium
Investigator:	T. Sarpkaya, Distinguished Professor of Mechanical Engineering
Sponsor:	Defense Advanced Research Projects Agency
Objective:	To perform experiments and analysis to determine the fluid-mechanical mechanisms which govern the rise and demise of trailing vortices in homogeneous and density-stratified media.
Summary:	A series of experiments has been carried out with rectangular foils, delta wings, and axisymmetric bodies in stratified and homogeneous media at various angles of attack. The formation of the sinusoidal instability, the vortex breakdown, and the vortex rings has been quantified and expressed in terms of the Vaisala-Brunt frequency, stratification parameter, and the normalized time. Furthermore, the effect of the axisymmetric body on the trailing vortices generated by the control surfaces of the body has been evaluated both analytically and experimentally.
Publications:	T. Sarpkaya, "The Rise and Demise of Trailing Vortices in Homogeneous and Density-Stratified Media," Proceedings of the International Conference on Advanced Topics in Aerodynamics and Aeroacoustics, Springer-Verlag, (forthcoming). T. Sarpkaya, "Trailing Vortices in Homogeneous and Density-Stratified Media," Journal of Fluid Mechanics 136, (November 1983), pp. 85-109. T. Sarpkaya, "Effect of Core Size on the Rise and Demise of Trailing Vortices," NPS-69-82-010, December 1982.
Conference Presentation:	T. Sarpkaya, "The Rise and Demise of Trailing Vortices in Homogeneous and Density-Stratified Media," Proceedings of the International Conference on Advanced Topics in Aerodynamics and Aeroacoustics, Stanford University, August 1983.
Theses Directed:	Cavit Turkmen, "Trailing Vortices in Stratified and Unstratified Fluids," Master's Thesis, December 1982.

Title:	Steady and Harmonically Oscillating Flow About Tube Bundles
Investigator:	T. Sarpkaya, Distinguished Professor of Mechanical Engineering
Sponsor:	Exxon Production Research Company
Objective:	To determine the drag, lift, and inertial forces on rectangular prisms and tube bundles subjected to steady and harmonically oscillating flow and to compare the results with those obtained with a single tube.
Summary:	Experiments have been carried out with two rectangular prisms, two tube bundles, and a single circular cylinder in steady and oscillating flow. The results have shown that the resistance of the prisms and bundles depend on the angle of attack, Reynolds number and the Keulegan-Carpenter number. In some cases the resistance of the prisms can exceed that of a bundle. The average resistance experienced by a tube in a bundle can exceed that of a single cylinder at low values of the Keulegan-Carpenter number. At higher values of the Keulegan-Carpenter number, the said average resistance may be below that experienced by a single cylinder. Additional experiments are needed to cover a large range of angles of attack and tube array combinations in order to delineate the differences in resistance of prisms and tube arrays.
Publications:	T. Sarpkaya, "Steady and Harmonically Oscillating Flow About Tube Arrays," (Report in preparation).
Thesis Directed:	M Storm, "Oscillating Flow About Cylinders," (In progress).

Title:	Improved Analytic Model for Waste Heat Recovery System
Investigator:	Paul F. Pucci, Professor, Mechanical Engineering Department
Sponsor:	None in FY83
Objective:	To improve an analytic model of a waste heat recovery system for a gas turbine propulsion engine developed by R. M. Combs (Sep 79, MSME thesis).
Summary:	The model was improved by allowing the use of non-uniform distributions of exhaust gas entering the waste heat recovery system, and predicting the effects of such a non-uniform distribution on the performance.
Thesis directed:	S. L. Wesco, "An Improved Model for a Once-Through, Counter-Cross-Flow Waste Heat Recovery Unit," Master's Thesis, September 1983.

Title:	Exhaust Gas Eductor Systems
Investigator:	P. F. Pucci, Professor, Mechanical Engineering Department
Sponsor:	None during FY83
Objective:	Design, fabricate and test scale models of gas turbine engine exhaust gas eductor systems for naval ships, in both cold-flow and hot-flow facilities.
Summary:	This research project was initiated by NAVSEA in FY76 and funded through FY81. Many eductor models have been tested and results reported during that period. During FY83, modifications to the shroud geometry of short mixing stack eductor systems were made and tested in both the hot-flow and cold-flow facilities. In addition, a fluted nozzle replacing the cyclindrical nozzles was tested in the cold-flow facility.
Theses directed:	E. Kavalis, "Effect of Shroud Geometry on the Effectiveness of a Short Mixing Stack Gas Eductor System," Master's Thesis, June 1983. D. Pritchard, "Characteristics of a Four Nozzle, Slotted Mixing Stack with Slanted Shroud, Gas Eductor System," Master's Thesis, June 1983. R. E. Staples, Jr., "Operational Performance of a Multiple Shrouded, Angled Diffuser Stack Gas Eductor in Turbulent Cross Flow," Master's Thesis, September 1983. J. Boykin, "Characteristics of a Fluted Nozzle Gas Eductor System," Master's Thesis, March 1983.

Title:	Ejector-Diffuser Improvement Program
Investigator:	P. F. Pucci, Professor of Mechanical Engineering
Sponsor:	Naval Air Propulsion Center
Objective:	Design, fabricate, install and test a cold-flow facility for the testing of scale models of ejector-diffusers for jet engine test cells.
Summary:	A cold flow facility was built and used for the testing of scale models of two existing NAPC ejector-diffuser systems. Geometric modifications were made on one model to improve its overall operational range. The operating range of the other system (a variable area geometry) was fully documented.
Theses directed:	"Design and Testing of scaled Ejector-Diffusers for Jet Engine Test Facility Applications," Molloy, James W., September 1983. "Variable Area Ejector-Diffuser Model Tests," Walsh, Thomas H., September 1983.

Title:	Development of a Library of Numerical Optimization Programs for Engineering Design
Investigator:	Garret N. Vanderplaats, Associate Professor of Mechanical Engineering
Sponsor:	NASA Langley Research Center, Hampton, Virginia
Objective:	To develop a library of FORTRAN programs for engineering design optimization using state-of-the-art techniques.
Summary:	The software has been forwarded to the sponsor in preliminary form and is undergoing final testing. The program has over 100 possible combinations of algorithms available for optimization.
Publications:	G. N. Vanderplaats, H. Sugimoto and C. M. Sprague, "ADS-1: A New General-Purpose Optimization Program," AIAA Journal (forthcoming). G. N. Vanderplaats, "A Robust Feasible Direction Algorithm for Design Synthesis," AIAA Journal, (forthcoming).
Conference Presentations:	G. N. Vanderplaats, H. Sugimoto, and C. M. Sprague, 'ADS-1: A New General-Purpose Optimization Program," Proceedings of the 24th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics and Materials Conference, Lake Tahoe, Nevada, May 1983. G. H. Vanderplaats, "A Robust Feasible Direction Algorithm for Design Synthesis," Proceedings of the 24th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics and Materials Conference, Lake Tahoe, Nevada, May 1983.
Theses Directed:	LeRoy Madson, "Design Optimization using the Augmented Lagrange Multiplier Technique," Master's Thesis, March 1981. James Fitzgerald, III, "Development of a Computer Program for Testing and Evaluation of Numerical Optimization Techniques," Master's Thesis, June 1982.

AVIATION SAFETY

Title:	Composite Materials Research
Investigator:	M.H. Bank, II, Associate Professor of Aeronautical Engineering and Safety
Sponsor:	Navy Strategic Systems Project Office
Objective:	To develop rational techniques for reinforcement around holes in structures made from graphite/epoxy composite materials.
Summary:	Computer studies using Lockheed Missiles and Space Company's DIAL computer code, and experimental work, have demonstrated that although asymmetric reinforcement (on one side only) around a hole does not increase panel strength under tension appreciably, symmetric reinforcement (on both sides) does. An increase of 29 to 40% over unreinforced panels has been demonstrated. Analysis and testing of panels under compression is under way.
Thesis directed:	D. Pickett, "Analysis of Symmetric Reinforcement of Quasi-Isotropic Graphite/ Epoxy Plates with a Circular Cutout under Uniaxial Tensile Loading," Master's Thesis, June 1983.

ANTISUBMARINE WARFARE

ACADEMIC GROUP

Title:	FBM Vulnerability and Effectiveness Research
Investigator:	R. N. Forrest
Sponsor:	Strategic Systems Project Office
Objective:	To analyze FBM vulnerability and effectiveness.
Summary:	A procedure for generating random tracks of specified length between two known endpoints was developed and analyzed.
Publications:	R. N. Forrest, "A Random Tour Process of Known Length Between Known End Points", NPS71-83-001.

COMMAND, CONTROL, & COMMUNICATIONS ACADEMIC GROUP

Title: Naval Warfare Gaming System (NWGS) Project

Investigators: James N. Eagle, Professor of Operations Research
Neagle R. Forrest, Professor of Operations Research
Rex H. Shudde, Professor of Operations Research
Michael G. Sovereign, Professor of Operations Research
Alan R. Washburn, Professor of Operations Research

Objective: To evaluate and enhance the warfare models in the Naval Warfare Gaming System.

Summary: This project was sponsored by OP 953, Navelex PME 120 and the Naval War College. Professors Eagle, Forrest, Shudde, Sovereign and Washburn participated in the analysis of modules of the NWGS software. Each produced a report making recommendations for improvements in the submarine, MAD, satellite C^3 and mine warfare areas respectively. These recommendations were discussed with the sponsors.

Research Reports:

J. N. Eagle, "The Modelling of Spiral-Search Torpedoes and Depth Bombs in the Wargaming System", August 1983, 18 pages.

R. N. Forrest, "Mad Detection and the NWGS", Nov 1983, 23 pages.

R. H. Shudde, "An Analysis of the Kinematics Model in the NWGS", Sept 1983, 12 pages.

M. G. Sovereign, "C^3 Concept for Enhanced NWGS", November 1983, 44 pages.

A. R. Washburn, "Mine Warfare in NWGS", March 1983, 10 pages.

Thesis Directed:

C. W. Wren, "Evaluation of the Torpedo Model in the NWGS", Master's Thesis, March 1983.

L. Fisher, "Evaluation of the SOSUS Model in the Naval Warfare Gaming System", Master's Thesis, March 1983.

D. M. Cashbaugh, "Examination of the Sonar Detection Models Used by the NWGS", Master's Thesis, March 1983.

D. T. Stokowski, "Analysis of the NWGS Surface-to-Air Missile Routine", Master's Thesis, September 1983.

Title: Distributed Wargaming

Investigator: J.M. Wozencraft, Professor of Electrical Engineering

Sponsor: Office of Naval Research

Objective: To investigate the feasibility of developing a computer and communications network architecture suitable for supporting large-scale command and control wargames, which are distributed in the sense that the participants are co-located with their own units in the field.

Summary: The flow and organization of information necessary to support distributed gaming has been studied, and the channel capacity of the communications network identified as the critical bottleneck. Work has been focussed on developing analytical models for aggregating game information and reducing communication requirements.

Publications: J.M. Wozencraft & P.H. Moose, "Lanchester's Equations and Game Theory", NPS Technical Report (in preparation)

R.K. Huber & J.M. Wozencraft, "On Distributed Wargaming in Operational C^2 Systems Using Object-Directed Programming Languages", NPS Technical Report (in preparation)

Conference Presentation: Fourth MIT/ONR Workshop on Distributed Information and Decision Systems Motivated by Command-Control-Communications Problems, June 1983, Cambridge MA

Workshop on Military Science and Operations Research in Defense Planning and the Operational Art, May 1984, NPS

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