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NAVAL POSTGRADUATE SCHOOL

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A SUMMARY OF THE
FOUNDATION RESEARCH PROGRAM
January 1981
Report for the Period
1 October 1979 to 30 September 1980

Approved for Public Release; distribution unlimited

Prepared for:
Chief of Naval Research
Arlington, Virginia 22217

Chief of Naval Development
Washington, D. C. 20360

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

Rear Admiral John J. Ekelund

David A. Schrady
Acting Provost

The work reported herein was supported by the Chief of Naval Research, Arlington, Virginia 22217 and the Chief of Naval Development, Washington, D. C. 20360.

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This report was prepared by:


WILLIAM M. TOLLES
Dean of Research

Released by:


DAVID A. SCHRADY
Acting Provost

Approved by
Date
Signature
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Forty-three projects of Independent Research/Independent Exploratory Development were funded by the NPS Foundation Research Program. This research was in the areas of Computer Science, Mathematics, Administrative Sciences, Defense Resources Management, Operations Research, National Security Affairs, Physics and Chemistry, Electrical Engineering, Meteorology, Aeronautics, Oceanography and Mechanical Engineering. A tabulation in Appendix I identifies area of research and the investigator(s). The category of independent research or independent exploratory research is also identified for each research task.		

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FY 1980 FOUNDATION RESEARCH

I. Introduction

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

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

In fulfillment of the research and development program objectives and within the above constraints, the Naval Postgraduate School

Initiates and conducts scientific and applied research (6.1) of a long-range nature in areas of special interest to the Navy.

Conducts exploratory development (6.2) deriving from scientific program areas or in other areas specifically requested by the Navy.

In addition, NPS performs scientific research and exploratory development, where uniquely qualified, for other agencies of the Department of Defense and, in defense related efforts, for other Federal Government agencies. NPS also furnishes consulting services for the Navy and, where specifically qualified, for other agencies of the Department of Defense and in defense related efforts for other Government agencies.

II. Background on the NPS Research and Development Program

The Navy has developed the Naval Postgraduate School as an academic institution which uses university educational methods to address the special graduate education requirements of the Navy. The Superintendent of the Naval Postgraduate School is a Rear Admiral of the line of the Navy. He is supported by a dual management structure, part military and part civilian. The faculty, mostly civilian, is responsible for the academic programs and, in support of these, conducts an active research effort. The military staff specifies the educational needs of the Navy, in terms of curricula, and provides administrative logistic support.

At the Naval Postgraduate School, as in other academic Institutions, the faculty is organized into departments. The department represents a resource center of faculty members with allied disciplinary specialization. Currently, the departments at the Naval Postgraduate School include Computer Science, Mathematics, Administrative Sciences, Defense Resources Management Education Center, Operations Research, National Security Affairs, Physics and Chemistry, Electrical Engineering, Meteorology, Aeronautics, Oceanography and Mechanical Engineering. Inter-disciplinary groups which have effective departmental status include Acoustics, Anti-Submarine Warfare, Electronic Warfare and Command, Control and Communication (C3).

Research and development projects are largely conducted by the individual faculty members on a project basis. Projects typically originate from proposals prepared either by individual faculty members, or by groups of faculty members from the same or different departments.

The research program is divided administratively into two parts. First is the Sponsored Research Program. This program includes projects awarded by sponsoring agencies to an individual principal investigator. The principal source of funds is the various commands and laboratories of the Naval Material Command. The sponsored program constitutes about 80% of the total NPS research program. The Foundation Research Program is based on a grant from the Chief of Naval Research and the Chief of Naval Development. This program is administered internally by a Research Council. The Council meets periodically to review faculty proposals, allocate fundings, and review results of completed projects.

Appendix I identifies each project by title and category or type funding (Basic Research - 6.1 and Exploratory Development - 6.2). The 6.1 category was funded by the Chief of Naval Research, Arlington, Virginia 22217 and the 6.2 category was funded by the Chief of Naval Development, Washington, DC 20360.

This report summarizes the FY 1980 Foundation Research Program.

Title: Exploration of Performance Prediction Techniques for Advanced Computer Architectures

Investigator: Lyle A. Cox, Jr., Assistant Professor of Computer Science

Sponsor: NPS Foundation Research Program

Objective: Establish a testbed facility and develop efficient concurrent computer system design and evaluation techniques.

Summary: This research effort has resulted in the establishment of a 16 bit microprocessor development system within the Computer Science Department's Microprocessor Laboratory. This system is dedicated to the analysis and simulation of complex, advanced computer systems. Of particular interest are systems capable of significant concurrency or parallelism. Such units constructed to date have generally not lived up to their promise, being expensive and difficult to program. In order to understand how such systems respond and to be able to economically explore alternative configurations, design description languages and simulators have been implemented. These systems allow the designer/user to describe his hardware and software systems and then predict the performance of such a hypothetical system. Results indicate that the petri-net concurrent control system techniques being developed are capable of providing efficient, accurate and easily used models of large scale digital systems.

Publications: Lyle A. Cox, Jr., "Performance Prediction from a Computer Hardware Description," Proc. Fifth International Symposium on Computer Hardware Description Languages, October 1979.

Lyle A. Cox, Jr., "Predicting Performance of Communications Networks from Formal Descriptions," Proc. International Telecommunications Conference, May 1980.

Theses

Directed:

D. L. Smith, "Method to Evaluate Micro-computers for Non-Tactical Shipboard Use," September 1979.

D. M. Stowers, "Computer Architecture Performance Prediction for Naval Fire Control Systems," December 1979.

S. C. Jennings and R. J. Hartell, "Petri-Net Simulations of Communications Networks," March 1980.

B. Hodgins, "Computer Evaluation thru Instruction Mix Sensitivity Analysis," (in progress).

Title: A Microprocessor Based Secure Archival Storage System

Investigators: Lyle A. Cox, Jr., Assistant Professor of Computer Science and Roger R. Schell, LTCOL, USAF, Assistant Professor of Computer Science

Sponsor: NPS Foundation Research Program

Objective: Specify, design and implement a verifiably secure archival storage system based on microprocessor technology. Such a system can serve as the "hub" of multi-level, secure network of computers sharing data and programs.

Summary: Security has been a continuing problem in developing and operating all types of computers, especially distributed networks of computers. Since these systems have the potential of allowing a wide audience of users to access sensitive data, they must be designed with caution. A technique for such system design, the "kernel technique," has been shown to be capable of providing the necessary security. Until recently, this technique could be implemented efficiently only on large computers. Recent advances in large scale integration microprocessors and "Winchester" disk storage system have made it possible to implement a secure archival system on a mini/micro scale. This scale is required for development of reliable distributed processing systems such as the "automated office" and the Navy's Shipboard Naval Administrative Processors (SNAP systems). Specifications, basic and advanced designs for this system have been completed and the project is currently in the early stages of implementing a demonstration testbed.

Publications: R. R. Schell and L. A. Cox, Jr., "The Naval Postgraduate School SECURE ARCHIVAL STORAGE SYSTEM: Part 1 - Design," NPS Technical Report NPS52-80-002, April 1980.

R. R. Schell and L. A. Cox, Jr., "A Secure Archival Storage System," Proceedings IEEE Computer Conference, September 1980.

Theses
Directed:

J. S. O'Connell and L. D. Richardson, "Distributed Secure Design for a Multi-Microprocessor Operating System," Master's Thesis, June 1979.

A. R. Coleman, "Security Kernel Design for a Microprocessor Based Multilevel Archival Storage System," Master's Thesis, September 1979.

E. J. Parks, "The Design of a Secure File Storage System," Master's Thesis, December 1979.

E. E. Moore and A. V. Gary, "Design and Implementation of the Memory Manager for a Secure Archival Storage System," Master's Thesis June 1980.

S. L. Rietz, "An Implementation of Multi-programming and Process Management for a Security Kernel Operating System," Master's Thesis, June 1980.

J. T. Wells, "Implementation of Segment Management for a Secure Archival Storage System," Master's Thesis, September 1980.

Title: Advanced Methods for Software Development

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

Sponsor: NPS Foundation Research Program

Objective: Continued development of the theory and a practical methodology for advanced software development.

Summary: This project has investigated software development in the general context of large-scale system development. To this end, it has pursued the following questions:

What are the most effective methods of designing and developing complicated systems?

What are the systems and tools needed to support these methods?

What machine architectures are needed to support these tools?

The AY80 research program investigated a number of approaches to the development of software systems and found them all inadequate. To a large extent this can be attributed to a lack of a comprehensive viewpoint of systems development.

One result of the AY80 program has been the identification of a system development paradigm. This paradigm characterizes the system development process as a multistage, iterative process of generating successively more refined models of the goal system. In this connection, a taxonomy of models was developed which divides models into two classes (analog and scale) and a number of subclasses. One conclusion is that system development tools should aid in the production of models. Determining if one system is a model of another system involves determining if they share certain properties and it now appears that this will require the use of the "knowledge representation languages" or "conceptual networks" under investigation by natural language specialists. This will be an area of research in the AY81 program.

Conceptual networks are pertinent to two other aspects of this research. In order to determine what makes systems complicated the AY80 project investigated a number of methods for measuring the complexity of systems. The method which seems most successful measures complexity relative to a given conceptual network. The AY81 research will continue the development of this complexity measure and develop the mathematical treatment of conceptual networks in general.

Another use of conceptual networks is the "intelligent programming database." This is a system development tool that was briefly investigated in the AY80 program. The intelligent programming database facilitates the use of existing software modules and components by "understanding" the function of those modules in terms similar to programmers. That is, the modules are organized in a conceptual network.

One of the important accomplishments of the AY80 program was the construction of mathematical explications of systems and a number of related concepts. This has enabled a number of informal ideas about system development to be put on a firm mathematical basis. This, in turn, will facilitate the derivation of tools to aid the software development process. This mathematical systems theory will be pursued in AY81 for its own sake in addition to its applications to the software development problem.

In summary, the AY80 research effort has provided a much better understanding of the problem and of several related research directions to be pursued for a solution. The AY80 research effort produced a large quantity of notes which are currently being incorporated into three research reports, described below.

Publications:

B. J. MacLennan, "General Properties of Very High Level Languages," (technical report, in preparation).

B. J. MacLennan, "Structural Analysis of Programming Languages - Preliminary Results," (technical report, in preparation).

B. J. MacLennan, "Introduction to Programming with a Relational Calculus," (technical report, in preparation).

Theses
Directed:

Four students are currently being directed in thesis work related to this project. Two are developing a retargetable compiler for Ada and two are investigating a method for automatically generating syntax-directed editors.

Title: Towards a Unified View of Search Techniques

Investigator: Douglas R. Smith, Assistant Professor of Computer Science

Sponsor: NPS Foundation Research Program

Summary: Necessary and sufficient conditions have been established for several kinds of representations of combinatorial problems under a certain model of dynamic programming. Problems have been found for which no dynamic programming representation can be used to generate all solutions. An algebraic model is being developed which allows the comparison (and generalization) of dynamic programming, divide and conquer, branch and bound, and greedy search techniques. Divide and conquer representations can be shown to be special cases of dynamic programs. Greedy representations can be shown to be special cases of branch and bound representations.

Publications: D. R. Smith, "Representation of Discrete Optimization Problems by Discrete Dynamic Programs," NPS Technical Report NPS52-80-004, February 1980,

D. R. Smith, "On the Computational Complexity of Branch and Bound Search Strategies," NPS Technical Report NPS52-79-004, November 1979.

D. R. Smith, "Generalized Dynamic Programming and Divide and Conquer Algorithms," (technical report in preparation).

Seminars: "Representation of Discrete Optimization Problems by Discrete Dynamic Programs," Operations Research Department Seminar, Naval Postgraduate School, June 1980.

Title: Investigation of Foutz Test for Goodness-of-Fit

Investigator: R. Franke, Associate Professor of Mathematics

Sponsor: NPS Foundation Research Program

Objective: The objective was to investigate the properties of the Foutz goodness-of-fit test and to determine the distribution of the statistic for various sample sizes.

Summary: Extensive simulations comparing the Foutz test with the Chi squared test and the Kolmogorov-Smirnov test were performed. Pseudorandom deviates from various distributions were generated and the abilities of the three tests in rejecting the hypothesis that the sample came from a normal distribution were compared. These tests showed the Foutz test to perform better than the other two when the distribution is heavy tailed. The exact distribution for sample size form was determined. Monte Carlo simulations have been performed and approximate percentage points as a function of sample size are being determined in continuing work.

Publications: R. Franke and T. Jayachandran, "Empirical Investigation of the Properties of a New Goodness-of-Fit Test," Journal of the American Statistical Society, (submitted for publication).

R. Franke and T. Jaychandran, "A Study of the Properties of a New Goodness-of-Fit Test," NPS Technical Report, NPS53-80-003, May 1980.

Title: Gaussian Stationary Markov Processes-
Prediction Problems

Investigator: Toke Jayachandran, Associate Professor of
Mathematics

Sponsor: NPS Foundation Research Program

Objective: Construct prediction intervals for future
observations of a first-order Gaussian
Markov Process.

Summary: First-order Gaussian Markov Processes (GSM)
are used extensively in modeling certain
economic and meteorological phenomena. It
would therefore, be of interest to obtain a
statistical prediction interval for the
next future observation based on all the
past or observed data. Such a prediction
interval has been constructed using half
of the observed data as conditioning vari-
ables. The properties of the interval as
the parameters of the GSM process vary
have been extended to obtain prediction in-
tervals for future observations in a linear
trend model. A technical report incorporat-
ing the results has been published and a
paper is under preparation for submission
to a technical journal for publication.

Publications: Toke Jayachandran, T. S. Murthy, "A Predic-
tion Interval for a First Order Gaussian
Markov Process," Technical Report NPS53-80-
002, April 1980.

Thesis
Directed: T. S. Murthy, "Prediction Intervals for
First Order Markov Processes," Master's
Thesis, September 1979.

Title: A Conjugate Gram Schmidt Algorithm in Constrained Minimization Problems

Investigator: I. Bert Russak, Associate Professor of Mathematics

Sponsor: NPS Foundation Research Program

Objective: To develop a version of the Conjugate Gram Schmidt (CGS) algorithm for constrained minimization problems. Also to determine the convergence characteristics of the algorithm.

Summary: Real world problems in constrained optimization occur very frequently in military applications, e.g., optimizing with respect to time to intercept, the parameters of a missile interceptor system subject to constraints on its motion. The topic of this project is to develop a numerical algorithm which solves such problems.

The CGS algorithm described in (1) applies to unconstrained minimization problems in this project. It is intended to extend that method so that it applies to the constrained minimization problems of minimizing a function $f(x)$ subject to the inequality and equality constraints

$$g_{\alpha}(x) \leq 0 \quad \alpha = 1, \dots, m', \quad g_{\beta}(x) = 0 \quad \beta = m' + 1, \dots, m$$

This also includes proving that the method converges and establishing characteristics of its rate of convergence.

The method of attack is to use a sequence of subproblems. These subproblems are then solved by a version of the CGS method. It is to be shown that the resulting sequence of solutions converges to the solution of the problem stated above.

This is a continuous project and the items thus far accomplished include: a) definition of the form of the approximating subproblem to use and b) definition of the particular modification to CGS to use in solving each subproblem.

Publication:

I. B. Russak, "Convergence of the Conjugate Gram Schmidt Method," to appear in Journal of Optimization Theory and Applications, Vol. 33, No. 2, February 1981.

Title: Industry Structure and Strategy: The Aerospace Industry

Investigator: Dan C. Boger, Assistant Professor of Economics

Sponsor: NPS Foundation Research Program and Office of Naval Research

Objective: Determine the influence of internal firm organization upon the performance of the individual enterprise using the aerospace industry as an example. This is the start of a longer term project which will examine all sectors of this industry, as well as other industries, from the same perspective.

Summary: Research has been directed specifically at the major aircraft and airframe manufacturers. Application of the Williamson paradigm to this sector of the aerospace industry has yielded the testable hypothesis that the financial performance of a sample of firms in this sector is a statistical function of the internal organization of the firm. Preliminary results are most encouraging, indicating a substantiation of the Williamson hypothesis for those firms for which data is currently available. The final model and analysis will occur upon completion of the data set concerning internal firm organization for the entire sample period for all firms.

Publication: A technical report is in progress.

Thesis Directed: R. W. McCabe, "The Aircraft Industry Since World War II: An Internal Organizational Approach," Master's Thesis, to be completed for March 1981 graduation.

Title: An Analysis of the Factors Affecting the Efficiency and Effectiveness of Management Control Systems

Investigator: Kenneth J. Euske, Assistant Professor of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: The project is being used to study the effects of the relative degree of differentiation and integration of management control systems upon the effectiveness and efficiency of those systems.

Summary: Progress is continuing on the Foundation research project. The specific management control systems and factors within those systems that will be investigated have been identified. The organizations that will be studied are now being selected. It is anticipated that the visits to and interviews with the sample organizations will be conducted during the fall and winter quarters. Due to a number of factors (e.g., scheduling difficulties and the travel freeze), the project is behind schedule. However, it is anticipated that the project will be completed early next year.

Title: Futures Planning in Organizations

Investigator: Roger Evered, Associate Professor of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: Development of theoretical framework for synthesizing the variety of planning activities evidenced in private and public sector organizations. Develops a typology of planning types and functions, and contrasts private and public sector planning.

Summary: A variety of planning conceptualizations have been collected from published literature and from interviews with selected public and private sector managers. The work is about half completed.

Publications: A 200 page book for the Little, Brown and Co. in "Policy and Planning" series is in process.

R. Evered, Futures Planning in Management: Bibliography, Council of Librarian, 1979.

R. Evered, "Management Education for the Year 2000," to appear in a book entitled Developing Managers for the 80's, ed. C. Cooper, Macmillian, 1980.

R. Evered, "Consequences of and Prospects for Systems Thinking in Organizational Change," in Systems Theory for Organizational Development, ed. T. Cummings, John Wiley, 1980.

Title: Strategic Acquisition/Resources Market Planning

Investigators: David V. Lamm, Assistant Professor of Acquisition, Ronald Schill, Adjunct Professor of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: The objective of this research is to examine specific issues within the defense industry which shape the nature of strategic planning emerging within prime contractor companies and to develop an empirical model explaining and analyzing the issues which (1) give rise to the increased need for strategic management of the corporate procurement function in these companies, and (2) are contained within the strategic planning process of the procurement function as it is occurring. The model will attempt to contrast and provide a taxonomy of issues which are specific to the defense industry and the Defense Department as the prime customer.

Summary: The research will have significant information to provide for potential changes in acquisition policy, source evaluation criteria, as well as major opportunities for initiatives involving changes in technological and materials/components long-range acquisition planning by contractors. Several companies provided liberally of detailed information on strategic planning procedures which will be of major benefit to defense contractors who are less sophisticated in conceptual/managerial planning techniques. Although all companies are rather weak in strategic planning as it pertains to procurement/technology planning, most expressed considerable interest in receiving the conceptual assistance and direction to improve this which the proposed prescriptive chapter will contain. The study also indicates significant capital risk taking by contractors beyond contract coverage in order to support contract effort, a factor which was not expected among the DOD managers interviewed.

Publication: Report in Preparation

Title: Measuring the Efficiency and Effectiveness of Governmental Activities

Investigator: Shu S. Liao, Associate Professor of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To study the feasibility, conceptually and empirically, of using the method of indirect cost allocation as practiced in the private sector to determine the full cost of delivering public services and measure the efficiency of governmental activities.

Summary: A framework is developed for disaggregating governmental entity activities until the element of activities is measurable. Four basic layers -- planning element and sub-element, program and subprogram, activity, and task are used to disaggregate activities for cost determination purposes. The disaggregated governmental activities resemble those of the production department of business organizations. Activities can then be classified into line function and support function. The costs of operating support function are then allocated to the line functions. The costs so accumulated become the basis for governmental activity efficiency measurement.

Conference Presentation: Shu S. Liao, "Performance Evaluation: A Missing Link in Public Sector Financial Management Education," Proceedings of the Third National Conference on Teaching Public Administration, May 1980.

Publication: A manuscript is in preparation for submission to Public Administration Review.

Theses Directed:

Grant G. Hintze, "Allocation of Allowable Indirect Costs in Management of Commercial/Industrial Activities," Master's Thesis, September 1980.

B. R. Benroth and R. F. Fremont, "Overhead Cost Accounting Model for Municipalities," Master's Thesis, in progress.

Title: The First Years Out Study -- Career Transitions: Facilitating Recruit Adaptation

Investigator: M. R. Louis, Assistant Professor of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: This study is part of a continuing research program the overall aims of which are to expand our understandings of career transitions. The characteristics of transition experiences, the cognitive and behavioral processes by which individuals cope with transitions, organizational practices for facilitating transitions, and the cultural features of organizational life involved in the acculturation of new members have been investigated to date.

Summary: The research program has resulted in the formulation of: a model of the cognitive processes by which individuals cope with transition experiences; a conceptual framework distinguishing among features of transition experiences; and a typology of career transition situations to aid in analyzing particular transition situations and integrating research across transition settings. A comparative analysis of alternative organizational practices aimed at facilitating transitions of new members was conducted. Cultural aspects or organizational life which play a major role in new member acculturation have been described and methods for empirical investigation of culture in organizations have been outlined.

Publications: M. R. Louis, "Career Transitions: Varieties and Commonalities," Academy of Management Review, 5, 3, July 1980, 329-340.

M. R. Louis, "Surprise and Sense Making: What Newcomers Experience in Entering Unfamiliar Organizational Settings," Administrative Science Quarterly, 25, 2, June 1980, 226-251.

M. R. Louis, "Socialization and Recruitment in Organizations: A Clash between Homeostatic and Adaptive Systems," Proceedings, Society for General Systems Research, January, 1980 (also presented at the 1980 Annual Meetings of the society in San Francisco).

M. R. Louis and R. Evered, "Alternative Perspectives in the Organizational Sciences: Inquiry from the Inside and Inquiry from the Outside," to appear in the Academy of Management Review.

M. R. Louis, "Organizations as Culture-Bearing Milieux," to appear in a book edited by Peter Frost on Organizational Symbolism, University of Chicago Press, 1981.

M. R. Louis, "Toward an Understanding of Career Transitions," in Work, Family and The Career: New Frontiers in Theory and Research, by C. B. Derr, Praeger Press, 1980.

Conference
Presentations:

M. R. Louis, "Learning the Ropes:" "What Helps New Employees Become Acculturated?" Presented at the Annual Academy of Management Meeting, Detroit, August 1980.

M. R. Louis, "A Cultural Perspective on Organizations: The Need for and Consequences of Viewing Organizations as Culture-Bearing Milieux," Presented at the Annual Academy of Management Meetings, Detroit, August 1980.

Title: An Empirical Study of Information Gathering Behavior

Investigator: Norman R. Lyons, Associate Professor of Management Information Systems, Department of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To study the information gathering behavior of individuals using an economic computer game. The experimental environment will be manipulated so that a variety of information and resource conditions are tested. In addition, tests will be given to subjects to determine their propensity for risk taking behavior. The usage of information and the types of information requested by the subjects will be studied.

Summary: The Foundation granted funds for this study during Winter Quarter, 1980. During that time, the basic computer models for the game were set up on the IBM 360/67 system, a test instrument was developed, and preliminary runs were made on one of the classes in Management Information Systems. Some problems developed because the computer system at the school is in the last days of its existence, and it is not really capable of handling the demands placed on it by a game of this type. For the Information Game to work properly, it is necessary for the subject's jobs to get turn-around within about a minute. Normally, this is possible on the configuration at the school. However, toward the end of a quarter, this becomes a more difficult goal to attain. All of the computer programs are in place, but the completion of the experiments in this study may have to wait until the IBM 3033 system is fully operational early next year.

Publications: One article has been submitted for publication based on analysis of the risk-taking test. It is co-authored with Phillip Ein-Dor and is titled "Risk Taking Behavior: An Empirical Study" and it has been submitted to the American Journal of Psychology.

N. R. Lyons, "The Information Processing Game: An Experimental Tool for the Study of Information Processing Behavior," to be published in Simulation and Games.

Title: The Functions of Visual Mental Imagery

Investigator: Roger Weissinger-Baylon, Associate Professor of Management Information Systems, Department of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To discover the functions of visual mental imagery in problem-solving and decision-making. In addition to its contribution to the theory of cognitive processes, tracing complex processes with mental imagery, a technique with many applications in design and evaluation of computer information systems.

Summary: Visual mental imagery protocols of mathematical problem solving contradict arguments by Nisbett and Wilson (1977) against the validity of protocol data in information processing psychology; my analysis is incompatible with Pylyshyn's (1973) characterization of mental images as epiphenomena, which I operationalize as stochastic independence between errors in reported mental images and problem-solving solutions. The rejection of stochastic independence (Fisher's exact test) suggests that mental imagery protocols provide valid traces of cognitive processes; moreover, images are not epiphenomena. As observed earlier by Arnheim (1969), Weissinger-Baylon (1978), Feigenbaum (1978) and Johnson-Laird (1979), mental images are important because they function as models of problems.

Conference Presentations: "Visual Mental Imagery Is Not an Epiphenomenon," Cognitive Science Society, 2nd annual meeting, Yale University, New Haven, Connecticut, June 1980 (abstract published in proceedings).

"The Functions of Visual Mental Imagery in Mathematical Problem Solving," Fourth American Conference on the Imaging Process, San Francisco, November 1980. (Proceedings are to be published in a book by Random House).

"Analyzing Executive Decision-Making Processes: the Methodological Contribution of Visual Mental Imagery," Philadelphia Pennsylvania, December 1980. (Referred contributed paper accepted for publication in proceedings).

Thesis
Directed:

Frederick Soctekouw, "A Response Evaluation Approach: An Aid for Computer Assisted Instruction Lesson Writing," Master's Thesis, September 1980.

Title: Sequential Testing for Selection

Investigator: R. W. Weitzman, Associate Professor of Administrative Sciences

Sponsor: NPS Foundation Research Program

Objective: To develop and test on Monte Carlo data a method of sequential aptitude testing for prediction of school success or failure with predesignated error probabilities (short-term) and to adapt this method for use with real data.

Summary: Like adaptive testing, sequential testing requires the presentation of one item at a time. The goal of adaptive testing is error variance, however, the goal of sequential testing is to control the probabilities of selection errors: α , the probability of incorrect acceptance, and β , the probability of incorrect rejection. Varying these probabilities along with item difficulty and discriminability, this study found in 96 Monte Carlo studies of 1,000 examinees each that the number of items required tended to be larger for items of low than high discriminability and for low rather than high error probability. For $\alpha = .05$ and $\beta = .05$ with a 25% failure rate at school, for example, the mean test length was 10 for high-discriminability items and 37 for low items while the corresponding mean test lengths under the same conditions for $\alpha = .15$ were 5 and 15. Predicted error rates were close to observed error rates particularly for the longer tests. These results suggest that in applications the strategy should be to fix α low to control the quality of accepted applicants while fixing β to control mean test length. The next research step is to adapt the method to real data, where estimation of the probability of correctly responding to an item as a function of school performance appears to be the major problem. I expect to seek further Foundation support for this effort. The method, if it works on real data, can be useful for recruit selection and assignment.

Publication: R. A. Weitzman, "Sequential Testing for Selection", NPS Technical Report, NPS54-80-13, December 1980.

Conference Presentation: R. A. Weitzman, "Sequential Testing for Selection", Annual Meeting of the Psychometric Society, University of Iowa, May 1980.

Thesis Directed: R. S. Kayler, "Computerized Adaptive Testing: A Case Study," Master's Thesis, December 1980.

Title: Quantification of Values for Decisions with Multiple Objectives

Investigator: Peter D. Ivory, Assistant Professor of Defense Resources Management Education Center

Sponsor: NPS Foundation Research Program

Objective: Summarize the available techniques on evaluation analysis for public-service managers.

Summary: Presently DOD managers rank projects in order of priority for funding. The ranking method requires decision makers to subjectively evaluate both benefits, which may involve multiple objectives, and costs for each project, then rank the projects in order of preference. The evidence on the human ability to subjectively evaluate complicated alternatives suggests strongly that humans perform the task poorly. After reviewing the literature on the available techniques to assist decision-makers in their value judgements, a simple methodology to resolve value assessment is developed. For simple tasks ranking is the best technique. However if the dimensions of the value problem exceed seven and or if cost is important, a normalized-direct method with the benefit/cost ratio rule is a superior method. Finally for complex value judgements the Simple Multiattribute Rating Technique with the benefit/cost ratio rule resolves most value problems characterized by having multiple objectives and allocates resources optimally. All three techniques can be performed by public-service managers without the assistance of an evaluation analyst.

Publication: A NPS technical report is in progress.

Title: An Investigation of Localization and Tracking Procedures

Investigator: R. N. Forrest, Professor of Operations Research

Sponsor: NPS Foundation Research Program

Objective: To develop a passive acoustic sensor target motion analysis (TMA) procedure that uses data that is not used in existing procedures.

Summary: The research project is exploratory. A computer model has been developed that simulates an encounter between an acoustic source (target) and an acoustic sensor. As a reference, an existing TMA procedure has been investigated using the simulation. The procedure is being modified by the introduction of speed and range constraint distributions. The modification provides target course and speed distributions. The problem of characterizing the distributions in a practical way is being addressed. The ultimate goal of the research is the development of a procedure that will reduce the time required to obtain adequate weapon localization information.

Publication: A technical report describing the simulation and base line TMA procedure is being prepared.

Title: Modeling the Influence of Information on the Progress of Conflict or Combat by Mathematical and Computational Methods

Investigator: Donald P. Gaver, Professor of Operations Research and Statistics

Sponsor: NPS Foundation Research Program

Objective: Development of models to represent the effect of information flow and Command, Control, Communication (C³) activities on combat.

Summary: The research activity was devoted to developing models and approaches to representing C³ system effects on Lanchester-type attrition models. In particular, coordination payoff was modeled. Communication system models were also investigated, wherein interference and jamming featured.

Publication: Donald P. Gaver, "Models that Reflect the Value of Information in a Command and Control Context," NPS Technical Report, NPS55-80-027, October 1980.

Conference Presentation: D. P. Gaver, J. P. Lehoczky and R. Harvey, "Communication Queues Under Crisis Conditions," TIMS/ORSA Joint National Meeting, Washington, DC, May 1980.

Title: Enhancements to the LLRANDOM II Random Number Generator Package

Investigator: Peter A. W. Lewis, Professor of Operations Research

Sponsor: NPS Foundation Research Program

Objective: To complete development of the Assembly Language Program LLRANDOM II for rapid generation of arrays of uniform and non-uniform random numbers.

Summary: Newly developed methods for generating Gamma distributed random variables have been implemented in the GAMMA portion of LLRANDOM II, completing the development of the package. The philosophy behind the package was to provide arrays of uniform and non-uniform random numbers to users which have: (i) known and documented statistical properties; (ii) are efficiently computed; and (iii) are reliably computed. Unlike LLRANDOM I, all the sub-programs in LLRANDOM II are independent modules which follow all IBM standard linkage conventions and, therefore, can be called from all IBM high level languages (FORTRAN, PL (1, etc.)) which use the standard linkage conventions. A feature of LLRANDOM II is that two multipliers are provided for the primemodulus congruential random number generator and the package is written in such a way that up to ten multipliers can be included.

Publications: Two reports entitled "The New LLRANDOM II Package Random Number Generator Package" and "The New LLRANDOM II Package - Users Guide" are being completed. The program will be available to the users of LLRANDOM I. These users include Navy and other government facilities, universities and private businesses.

Title: Regional Cooperation in Southern Africa

Investigator: Michael Clough, Adjunct Assistant Professor
of National Security Affairs

Sponsor: NPS Foundation Research Program

Objective: To Analyze the prospects for successful
regional cooperation in Southern Africa
and to assess the implications for American
policy toward the region.

Summary: Final conclusions have not been reached.
Tentative results indicate that the current
efforts of the Southern African Development
Coordinating Conference (comprised of nine
states) to promote regional economic develop-
ment and reduced dependence on South Africa
must overcome a number of obstacles if they
are to succeed. Based on a review of pre-
vious efforts to promote regional economic
integration, it is unlikely that any large
scale comprehensive schemes focussed on
trade would have much chance of success.
The major problem is determining how to
distribute the costs and benefits of joint
efforts. Inevitably, each state believes
it is paying higher costs and receiving
smaller returns than other participating
states. For this reason, specific func-
tional programs such as improvement of
transportation networks offer the best hope,
provided each state clearly recognizes the
benefits it will derive from the project.
Efforts to reduce dependency on South
Africa are also likely to be difficult to
carry out. Since the costs of reducing
dependence will vary from state to state and
given the lack of a ready source of funds to
ease the short term burdens of reducing
dependence on South Africa, any attempt to
push too far, too fast is likely to fail.
However, over the long term it is essential
that these states reduce their dependence
on South Africa for two reasons: 1) If
there is large-scale civil unrest in South
Africa and these states remain dependent on
that state, they will be severely affected;
and 2) Regardless of the composition of the

South African government, the surrounding states will need to reduce their dependence on that country in order to promote balanced economic development in their own countries. The evidence to date indicates that the nine members of the SADCC are proceeding cautiously and pragmatically.

Publications:

A chapter co-authored by Michael Clough and John Ravenhill (Assistant Professor, University of Virginia) will appear in a book to be edited by Michael Clough that will be published sometime in 1981; another version of this paper may be published in World Development.

**Conference
Presentation:**

Paper presented to Zimbabwe Economic Symposium in Salisbury, Zimbabwe by Michael Clough on September 9, 1980.

Title: The Economic Impact of Arms Transfers to Less Developed Countries with an Application to the Internal Economic Growth and Stability of Pre-Revolutionary Iran

Investigators: Robert Looney, Associate Professor, National Security Affairs, Edward Laurance, Associate Professor, National Security Affairs and Peter Frederiksen, Associate Professor., D.R.M.E.C.

Sponsor: NPS Foundation Research Program

Objective: The major objective is to develop a methodological framework capable of analyzing the economic implications of arms expenditures on the economies of less developed countries. This includes identifying those variables that are constraints or modifying economic growth in these countries, and the impact of defense expenditures on those constraints.

Summary: The research program has a number of inter-related facets. On a worldwide level data for over one hundred developing countries is being analyzed by cluster and discriminate analysis for patterns of defense expenditure and economic growth. Preliminary results for a smaller sample indicated that developing countries tend to fall into two major groups, one where increased defense expenditure apparently aids income growth (or at least is no impediment to expansion) and another where added defense expenditures appear to retard growth. In particular, we are examining whether the post-OPEC price increase period has fundamentally changed these relationships, and if so in what manner. To obtain a more precise picture as to the mechanism by which defense expenditures impact on a developing country, we have built full-scale macro-economic models for Mexico, Saudi Arabia, and Iran. In each model defense expenditures have been incorporated as a policy variable and an impact matrix computed. Preliminary results are consistent with worldwide findings; i.e., that resource constrained countries (Iran

and Mexico) must divert resources from economically productive activities to expand defense expenditures where resource unconstrained countries (Saudi Arabia) suffer no adverse effects in this regard and in fact derive positive side benefits from added military expenditure.

Finally, we are examining one country, Iran in great detail to obtain a better understanding of the interrelationship between political, economic and military decision making in developing countries. That work is specifically attempting to identify the role of defense expenditures in causing mass alienation and a revolutionary environment. Preliminary results indicate that Iran is a classic case of Gerr's theory of revolutions.

Preliminary results have been encouraging, and we plan on both expanding our scope and seeking outside funding--ACDA in particular.

Publication:

A paper with our initial model and results on defense expenditures and economic growth was submitted to Economic Development and Cultural Change. Apparently three reviewers have recommended its publication (with changes), but we have not received final confirmation.

Conference Presentations:

Our initial results were presented at the Atlantic Economic Association Meetings, Boston, October 12, 1980.

Our further findings were presented at the Southern Economic Association Meetings, Washington, DC, November 5, 1980.

Title: Communist Countries and Africa

Investigators: Jiri Valenta, Associate Professor of National Security Affairs and Dr. D. Albright, Senior Editor for Problems of Communism

Sponsor: NPS Foundation Research Program

Objective: To revise, update and edit an anthology which would assess the military involvement of communist countries in Africa. This study stems from and is the continuation of an earlier project.

Summary: This project continues to advance as each contributor updates and revises his respective chapter in the anthology. The principal investigator, J. Valenta has rewritten and updated a chapter of the book which he is editing with D. Albright.

Publications: J. Valenta and D. Albright (eds.), Communist Countries and Africa (Bloomington: Indiana University Press, 1981).

J. Valenta, "The Communist Countries and the Horn of Africa," J. Valenta and D. Albright, (eds.), Communist Countries and Africa (Bloomington: Indiana University Press, 1981).

J. Valenta, "Soviet-Cuban Intervention in Ethiopia, 1978," Journal of International Affairs, Vol. 34, No. 2, January 1981.

J. Valenta and S. Butler, "East German Policies in Africa," Eastern Europe and the Third World (New York: Praeger Press, 1981).

Theses Directed: S. Butler, "Brotherhood-in-Arms: East German Foreign Policy in Africa," Master's Thesis, June 1980. (Recipient U.S. Naval Institute Award. Graduated with Distinction).

W. Nurthen, "Soviet Strategy in the Red
Sea Basin," Master's Thesis, March 1980.
(Recipient U.S. Naval Institute Award.
Graduated with distinction.)

R. Mahlum, "U.S. Foreign Policy in Southern
Africa," Master's Thesis, June 1980.

Title: Soviet Decisionmaking for National Security

Investigators: Jiri Valenta, Associate Professor of National Security Affairs and Dr. William Potter, Assistant Director for the Center of International and Strategic Affairs at UCLA

Sponsor: NPS Foundation Research Program

Objective: To assemble papers and edit an anthology which would assess Soviet decisionmaking for national security, a subject previously explored in the investigator's book Soviet Intervention in Czechoslovakia, 1968: Anatomy of a Decision (Baltimore: Johns Hopkins University Press, 1980). To convene a three day conference on August 14-16, 1980 for the presentation of invited papers by leading national and international experts on the subject.

Summary: The conference fulfilled the stated objective of bringing together a large number of experts, twelve of whom delivered papers. NPS students enrolled in the area program assisted with the organization of the conference. The principal investigator, J. Valenta served as co-director of the conference, wrote and presented a paper, chaired one of the conference panels, and will co-edit the proceedings of the conference.

Publications: J. Valenta and W. Potter (eds.), Soviet National Security Decisionmaking (Baltimore: Johns Hopkins University Press, 1981).

J. Valenta, "Soviet Decisionmaking and National Security: A Comparison of the Czechoslovak and Afghan Invasions," J. Valenta and W. Potter (eds.), Soviet National Security Decisionmaking (Baltimore: Johns Hopkins University Press, 1981).

J. Valenta, "Czechoslovakia and Afghanistan: Comparative Comments," Studies in Comparative Communism, Vol. XIV, No. 4, Winter 1980.

Theses
Directed:

T. Milton, "Succession in the USSR,"
Master's Thesis, June 1981.

T. Wyckop, "The Legacy of Ideology in
Soviet Foreign Policy toward the West,"
Master's Thesis, June 1981.

Title: French and Soviet Perspectives on Theater Nuclear Policy and Arms Control

Investigator: David S. Yost, Adjunct Assistant Professor of National Security Affairs

Sponsor: NPS Foundation Research Program

Objective: Advance understanding of NATO interests and perceptions regarding possible theater nuclear arms control negotiations.

Summary: The first phase of this project (Summer 1980) focused primarily on France (in the context of NATO Europe in general), while the second phase (winter or spring 1981) will focus on the Soviet Union. Results so far have clarified West European perceptions of SALT II and SALT III issues, including the arguments of West European supporters and critics of SALT II. Moreover, the complex internal debate in France regarding relevant defense issues has been thoroughly analyzed.

Publications:

D. S. Yost, "Beyond SALT II: European Security and the Prospects for SALT III," in Orbis, 24, 3 (1980).

D. S. Yost, "The French Defense Debate: Schools of Thought and Probabilities," in Survival, 23, (1981).

D. S. Yost, "SALT and European Security," in D. S. Yost, ed. NATO's Strategic Options: Arms Control and Defense (New York: Pergamon Press, 1981).

D. S. Yost, Der SALT-Prozess und die sicherheitspolitische Lage Westeuropas (Sankt Augustin/Bonn, West Germany: Konrad-Adenauer-Foundation, 1980).

D. S. Yost, review article on 2 new French books on European security, in Survival, 22 (1980).

Title: Classical Trajectory Studies of Low Energy Ion Impact Mechanisms on Clean and Reacted Single Crystal Surfaces

Investigators: Don E. Harrison, Jr., Professor of Physics and Chemistry, K. E. Foley, B. J. Garrison, and N. Winograd, Pennsylvania State University

Sponsor: National Science Foundation and NPS Foundation Research Program

Objective: 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.

Summary: Classical trajectory simulations have developed to the point that it 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 sputtering 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 established that vacuum phase recombination of atoms is the preferred mechanism of molecular cluster formation. The energy distributions of sputtered atoms supports this interpretation. The influence of the ion-atom potential function on sputtering has also been examined. The sputtering yield has been shown to be a function only of the magnitude of the ion-atom potential function is a sensitive separation range.

Publications: N. Winograd, K. E. Foley, B. J. Garrison and D. E. Harrison, Jr., "Evidence for a Recombination Mechanism of Cluster Emission from Ion Bombarded Metal Surfaces," *Physics Letters* 73A(3), 253-55 (1979).

D. E. Harrison, Jr., "Atom Ejection Studies by Classical Trajectory Simulation," AIP

Conference Proceedings No. 61, Aspects of the Kinetics and Dynamics of Surface Reactions (La Jolla Institute-1979) ed. U. Landman, American Institute of Physics, New York, 1980., pp. 307-18.

D. E. Harrison, Jr., B. J. Garrison and N. Winograd, "Atom Ejection Mechanisms and Models," Secondary Ion Mass Spectrometry: SIMS II, ed. A. Benninghoven, et. al., Springer-Verlag New York (1979), pp. 12-14.

B. J. Garrison, N. Winograd and D. E. Harrison, Jr., "Classical Trajectory Calculations of the Energy Distribution of Ejected Atoms from Ion Bombarded Single Crystals," Surface Science 87, 101-111 (1979).

D. E. Harrison, Jr., "Full Lattice Simulations of Atom Ejection Mechanisms," Proceedings: Symposium on Sputtering, Perchtoldsdorf/Vienna, Austria, April 28-30, 1980, ed. P. Varga, et. al., pp. 36-61. (unpublished).

**Conference
Presentations:**

D. E. Harrison, Jr., "Full Lattice Simulations of Atom Ejection Mechanisms," Symposium on Sputtering, Perchtoldsdorf/Vienna, Austria, April 28-30, 1980.

Title: Spectroscopic Data Center Compilation of Atomic Energy Levels

Investigator: Raymond L. Kelly, Professor of Physics

Sponsor: NPS Foundation Research Program

Objective: To produce a useful, comprehensive, and semi-critical compilation of atomic energy levels, based on publications listing spectrum lines. The compilation is to be stored on magnetic tape, in order to be available to a large community of users, and is to be updated regularly on a continuing basis.

Summary: The initial phase of the compilation has been completed for the first 24 elements, Hydrogen through Chromium, for all stages of ionization. Such information makes possible classification of unidentified lines from plasma sources and in solar spectra, as well as the prediction of other lines (valuable in laser physics).

Publications: Raymond L. Kelly and Don E. Harrison, Jr., "Ionization Potential of Fe XVII in the Neon Isoelectric Sequence, Revised Value," Atomic Data and Nuclear Data Tables 19, 303-303 (1977).

Conference Presentation: Reported at VI International Conference on Vacuum Ultraviolet Radiation Physics, Charlottesville, VA, June 1980.

Title: Plasma Surface Interaction

Investigator: Fred Schwirzke, Associate Professor, Department of Physics and Chemistry

Sponsor: NPS Foundation Research Program

Objective: To investigate unipolar arc damage of several materials, including stainless steel and TiC.

Summary: Plasma surface effects are of importance during the operation of high power plasma facilities like beam weapons, some high power lasers, high power x-ray generators, high power switches and controlled thermonuclear fusion devices, when material surfaces are exposed to particle and photon fluxes from a hot plasma. Such exposure causes surface damage via physical and chemical sputtering, evaporation and unipolar arcing. The last one, arcing, represents one of the most damaging plasma surface interaction processes. Arc craters produced by plasma surface contact were detected with the scanning electron microscope on a stainless steel surface which was exposed to the plasma produced by a Q-switched laser pulse. The laser produced plasma with an electron temperature of about 100 eV expands rapidly from the focal spot on the target surface in normal and in radial direction. Although no external voltage is applied, about 20,000 unipolar arc craters are observable on the stainless steel surface which was exposed to the radially expanding plasma for the short time of a few hundred nanoseconds. The size of the arc craters becomes smaller with increasing distance from the focal spot. This evidence shows that a laser produced plasma can be used to study plasma surface effects.

Publications: F. Schwirzke and R. J. Taylor, "Surface Damage by Sheath Effects and Unipolar Arcs," *Journal of Nuclear Materials*, 94 and 95, (1980).

F. Schwirzke, "Arcing, an Experimental Investigation of Plasma Surface Interaction," Bull. Am. Phys. Soc., 24, 971 (1979).

Conference

Presentations:

F. Schwirzke, "Arcing, an Experimental Investigation of Plasma Surface Interaction," 21st Annual Meeting of the Division of Plasma Physics of the American Physical Society, Boston, MA, 12-16 November 1979.

F. Schwirzke and R. J. Taylor, "Surface Damage by Sheath Effects and Unipolar Arcs," 4th International Conference on Plasma Surface Interactions in Controlled Fusion Devices, Garmisch-Partenkirchen, Germany, 21-25 April 1980.

F. Schwirzke, D. J. Armstrong and J. H. Cowitch, "Generation of Acoustic Pulses in Water by Laser Induced Breakdown," 1980 IEEE International Conference on Plasma Science, 19-21 May, 1980. Conference Record - Abstract, IEEE Catalog No. 80CH1544-6 NPS, p. 65 (1980).

Theses

Directed:

M. T. Kelville and R. W. Lautrup, "An Investigation of Unipolar Arcing Damage on Stainless Steel and Titanium Carbide Coated Surfaces," Master's Thesis, June 1980.

J. H. Barker, III, and R. J. Rush, "Plasma Surface Interactions," Master's Thesis, December 1980.

Title: Underwater Acoustic Noise Due to Surf Phenomena

Investigators: O. B. Wilson, Jr., Professor of Physics and Chemistry, Stephen N. Wolf and Frank Ingenito, Naval Research Laboratory

Sponsor: NPS Foundation Research Program and Naval Sea Systems Command

Objective: To determine whether surf generated noise is a significant component of the shallow water ambient noise.

Summary: Horizontal directionality of ambient noise was measured at ranges up to 4 km from the eastern shore of Monterey Bay, California. Water depths at the sites ranged from 8 to 73 m. A steerable cardioid receiving pattern was formed using signals telemetered from dipole and omnidirectional hydrophones suspended from tethered buoys. With no nearby shipping, whenever the maximum of the cardioid pattern was directed toward the beach, noise levels in the range 20 to 500 Hz were greater than those obtained when the maximum was directed seaward. This difference (seaward vs. shoreward), which depended on range from the beach and on frequency, was 7 dB at 100 Hz at the 4 km site. Surf beat was clearly audible when the cardioid maximum was steered shoreward at ranges as great as 2 km. The measurements, made when wind and surf were high, suggest strongly that under some conditions breaking surf can contribute significantly to ambient noise in fairly deep continental shelf waters.

Publications: A manuscript is in preparation and will be submitted to the Journal of the Acoustical Society of America.

Conference Presentations: The results will be reported in the Fall 1980 meeting of the Acoustical Society of America.

Title: Millimeter Wave Transmission Media

Investigator: J. B. Knorr, Associate Professor, Electrical Engineering Department

Sponsor: NPS Foundation Research Program

Objective: The objective of this research is to study transmission media for millimeter wave integrated circuits and to obtain solutions to unsolved problems in the areas of wave propagation, discontinuities circuits and components.

Summary: The progression of electronic technology to the present time has permitted the realization of electronic systems utilizing the electromagnetic spectrum up to about 40 GHz. Utilization is heavy through 12 GHz and decreases to sparse between 12 GHz and 40 GHz. Parallel developments at "optical" frequencies have led to utilization of the spectrum above 300 GHz. Here utilization is heavy near the visible portion of the spectrum ($\lambda = 1 \mu\text{m}$ or $f = 300 \text{ THz}$) and decreases rapidly below this frequency. There thus exists a gap in the utilization of the electromagnetic spectrum the millimeter wave region from 40 - 300 GHz.

It has become clear that there are certain military requirements that can be uniquely satisfied by systems operating in the 40-300 GHz millimeter wave band. Millimeter wave systems which are currently being investigated to satisfy the requirements include missile seekers, radar, mapping, communications and electronic warfare. In this band, however, the realization of practical systems awaits the solution of some basic problems.

One of the major impediments to the realization of millimeter wave systems is the lack of devices and components for use in the band. Devices and components which are available are costly and offer only limited performance. At microwave frequencies, waveguide and printed lines such as microstrip and slotline have been proven optimum for the realization of components, devices and integrated circuits. At optical frequencies, dielectric fibers have been developed to very high quality and dielectric integrated optical circuits are being pursued.

The identification of optimum transmission media for millimeter wave applications is an area of current interest. Various structures must be studied and compared with particular attention being given to those suitable for mass production. This will then allow the development of high quality components and devices at a reasonable cost.

The Millimeter Wave Transmission Media Project has thus far focused on theoretical and experimental studies of millimeter wave fin-lines and fin-line discontinuities. The emphasis has been directed toward careful comparison of numerical and experimental data and the production of results which are of practical use in design applications. Curves of impedance and wavelength of fin-line have been published for the millimeter wave bands. Work on the representation of a bifurcating septum in fin-line is near completion and several other fin-line discontinuities are currently being investigated. This work will be reported when complete. The results will be useful for the design of various fin-line circuits and components.

Future plans for this continuing project include studies of other transmission structures and discontinuities and investigation of circuit applications of the generated design data.

Publications:

J. B. Knorr and P. M. Shayda, "Millimeter Wave Fin-Line Characteristics," IEEE Trans. Microwave Theory and Tech., Vol. MTT-28, pp.737-743, July 1980.

P. M. Shayda, "Spectral Domain Analysis of Fin-Line," Master's Thesis, December 1979

G. Miller, "An Experimental Investigation of Several Fin-Line Discontinuities," Master's Thesis, December 1980

Title: Magnetic Monitoring Station at Chews Ridge

Investigators: P. H. Moose, Associate Professor, Electrical Engineering Department, O. Heinz, Professor of Physics and Chemistry, E. Crittenden, Distinguished Professor of Physics and Chemistry.

Sponsor: NPS Foundation Research Program

Objective: To establish a magnetic monitoring station at Chews Ridge in order to develop long term background data, provide a reference site for correlation with ocean floor measurements and study propagation phenomena of magnetospheric micro-pulsations.

Summary: Choice of a suitable site was pursued early in the year by examination of the available charts, and discussions with geological survey and others familiar with the area. Two aerial reconnaissance flights were made over the Santa Lucia Mountains and the Gabillan range and were followed up by ground expeditions, to check on the line-of-sight radio link possibilities. It was determined that Professor P. C. C. Wang, of the NPS Department of Mathematics, owned property just north and east of the Chews Ridge Forest service lookout. This site was proven by testing and analysis by a Communications Engineer Student to be satisfactorily located for low power VHF radio transmission to Spanagel Hall. Professor Wang kindly offered the use of his property for this work at no charge to the government and it was officially accepted by the Superintendent. Two superconducting SQUID magnetic gradiometers have been located. One has been obtained on indefinite long term loan from Professor George Keller at Colorado State University at Golden. This arrived recently with some evidence of damage in transit. Determination of the extent of damage awaits funding to provide liquid helium for cool down. A second superconducting SQUID magnetic gradiometer has been obtained on a transfer of ownership basis. This magnetometer was purchased by the Navy for a project by Dr. Walter Podney of Physical Dynamics, Inc. La Jolla, CA, for joint work with Scripps

Institute of Oceanography on the magnetic fields generated by internal waves in the ocean. At the completion of that project it was loaned to Autonetics, for a project just completed. It has been returned to the Navy and temporarily moved to NOSC where it awaits transport to Monterey. As the magnetometer is very delicate, the present plan is to transport it to Monterey by Navy truck or on board the Acania when she next stops in San Diego.

Utilization of both magnetometers will require some refurbishing and purchase of liquid helium. As the magnetometers became available just at the end of FY 80 it was not possible to purchase the liquid helium then. Funding support is not being investigated to provide for the costs of refurbishing and operating these two magnetometers.

Both magnetometers that have been obtained are too large, and boil off too much helium to permit their use in submerged containers for ocean bottom measurements at great depths. After a period of gaining experience with these magnetometers, it is planned to design and build, or have built, a magnetometer for ocean bottom use. Containers for retention of the evolved gaseous helium have been located and are available on indefinite long term loan. They are at present located at the Wood's Hole Oceanographic Institute.

A one watt VHF half-duplex two-channel telemetry system including a photovoltaic solar panel/battery storage power supply transmit/receive antennas and a remote receive/control station for location in Spanagel Hall have been ordered from Motorola, Inc. Delivery of this system is expected in early November 1980. Installation will be by separate contract for which additional funds are needed. Frequencies of 138.7 and 143.6 MHz have been assigned by the Navy frequency controller at Point Mugu. Dr. Tony Fraser-Smith from Stanford will be one of the first users of the on-line remote site data. He will be investigating the possibility of

generating a useful prediction of noise activity in the MAD frequency band. The initial sensors at the site will be large coil antennas. Periodic experimentation with the SQUID gradiometers will be undertaken as they become operational.

Thesis
Directed:

Phillip Beliveau, "Telemetry Design for Solar Powered Geomagnetic Monitoring Station,"
Master's Thesis, September 1980.

Title: Radar Target Identification Via Time-Domain Scattering Signatures

Investigators: M. Morgan, Assistant Professor of Electrical Engineering and M. Hamid, Adjunct Professor of Electrical Engineering

Sponsor: NPS Foundation Research Program

Objective: The long-range goal of this investigation is to establish the feasibility of developing advanced radar systems which are capable of target discrimination and classification via transient time-domain scattering returns. To achieve this objective a comprehensive research program has been established in transient scattering, both from the aspects of analysis-computation and experimental modeling measurements. The thrust of this effort is to extend both the accuracy of time-domain scattering calculations and measurements, as well as to investigate and experimentally implement workable inverse scattering radar target imagery schemes.

Summary: A new theoretical concept for calculations of electromagnetic scattering has been formulated by Professor Morgan and successfully applied to the basic problem of wire scattering by LT B. E. Welch in his M. S. thesis. This new formulation partitions the solution of scattering into two interacting operators which can be symbolically represented by a simple feedback network. The work thus far has been performed in the frequency-domain where the forward and feedback operators each reduce to multiport transfer matrices. The power of this method, which uses the finite-element method for the calculation of the forward operator, is in its flexibility to handle complex scattering body geometries, including penetrable media such as "composite" aircraft materials, radomes, and missile plasma exhausts.

The development of the time-domain laboratory commenced during the 1980 Winter Quarter. This work was undertaken by CAPT C.W.

Hammond as his M. S. thesis objective. The laboratory has evolved from a scale model representation to an operational system located in Room 703B of Spanagel Hall. The 36 x 36 foot image plane was welded successfully and no water leaked below throughout the winter season. Two antennas were constructed and are presently being tested and improved using the image plane facility. One of these antennas is a 20 foot wire monopole erected in the center of the image plane in order to transmit a high voltage pulse to the test target. Various test targets were fabricated out of aluminum and were fashioned so as to present symmetric geometrical configurations which can be viewed from different aspect angles. A broadband TEM horn antenna was also constructed and tested for receiving the field scattered from the test target. Beyond this horn the return signal is sent to the digital sampling oscilloscope below the image plane for analysis and display. The scope is linked to a Tektronix 4052 minicomputer which provides software to subtract the incident field from the total field.

Publications:

M. A. Morgan and B. E. Welch, "The Field Feedback Formulation," National Radio Science Symposium Digest, Boulder, CO, January 1981.

Theses

Directed:

B. E. Welch, "Concept Evaluation: Field Feedback Computation of Electromagnetic Scattering," Master's Thesis, June 1980.

C. W. Hammond, "The Development of a Bistatic Electromagnetic Scattering Laboratory Employing Time-Domain Measurement Techniques for Impulse Response Determination and Target Classification," Master's Thesis, December 1980.

Title: Enhancement of Computing Power of 16 Bit Microcomputer by Using Microcomputer Compatible Array Processor

Investigator: Tien F. Tao, Professor of Electrical Engineering

Sponsor: NPS Foundation Research Program

Objective: Investigate and develop the concepts, approaches and skills to enhance the computing power of 16 bit microcomputers by microcomputer compatible array processor with a longer range goal to use the combination of microcomputer and array processor in a multiple microcomputer system.

Summary: Interest in using 16 bit microcomputers for signal processing applications have been increasing at a rapid rate. However, the computing capabilities of today's microcomputers are limited for real time signal processing performance. This project is to determine the limitations today and to develop new methods to enhance their signal processing capabilities. The highlights of our progress will be presented in the following.

Development of a Benchmark Test Program-Image Processing Problem: An end-to-end multiple stages image processing program for detection of moving targets in noisy images has been developed as the benchmark test program. It will be described by presenting the images at various stages of the image processing as shown in Fig. 1. It includes several signal processing steps from the statistical temporal and spatial filters for background clutter suppression, a histogram counting procedure for adaptive thresholding, and several pattern recognition operations based on spatial, temporal pattern tests for target acquisition. Their diversified computations involving floating point real numbers and integer binary/digital numbers should provide a good benchmark test.

Selection of Signal Processing Resources: Two 16 bit microcomputers have been selected as the basic microcomputers. The first one

is the DEC LSI-11 microcomputer which has a physical address space of 64 Kbytes (16 address bits). It is being used as a single stand alone microcomputer. The second one is the Intel 8612 microcomputer which has a physical address space of 1 Mbytes. It is being used as the basic processing elements in a multiple microcomputer system.

Two microcomputer-compatible array processors have been selected as the special-purposes signal processor to enhance the computation capabilities of the microcomputers. The first one is the MSP-3 array processor of the CDA, Inc. The second one is the AP4000 array processor of the Analogic, Co. Both use the block floating point data format. MSP-3 must be programmed by microprogramming. The AP4000 provides a cross-assembler which allows the user to develop new signal processing subroutines using high order programming language.

Preliminary Results of Execution Times: The execution time of the benchmark test image processing program has been measured on three different computer/processor combinations: An IBM 360/67 mainframe computer, a 16 bit DEC LSI-11 microcomputer and a combination of LSI-11 microcomputer and the MSP-3 array processor. For the cases of 360 and LSI-11, Fortran is used as the programming language. Single precision data format is used. For the combination of LSI-11 and MSP-3, both Fortran and Macro-Assembly language are used for comparison. The data format is either the block-floating point or the integer. Execution times of individual subroutines have been measured and listed in this table. It can be seen that the complete end-to-end program has been coded for the LSI-11 microcomputer. It is being used to determine the limitation of signal processing capability of representative 16 bit microcomputers today. The execution times on the IBM 360 are used as a reference. Using the existing firmware provided by the manufacturer, the MSP-3 array processor has been able to enhance the computation power of the LSI-11 microcomputer in the temporal

and spatial filtering subroutines coded in Fortran on the LSI-11. However, because of the unavailability of appropriate firmware subroutines, the computation of both the temporal and spatial statistics have not been helped by the array processor at all. In fact, the computation time for the temporal statistics was increased almost three times. However, if Macro-Assembly language is used, better programming and data manipulation are possible as indicated by the reduction of execution times. It can be seen that the combination of a microcomputer and an array processor can be almost as efficient as the mainframe computer in these image processing computations. Further, if the integer format is used, the performance in execution times even surpass that of the mainframe computer.

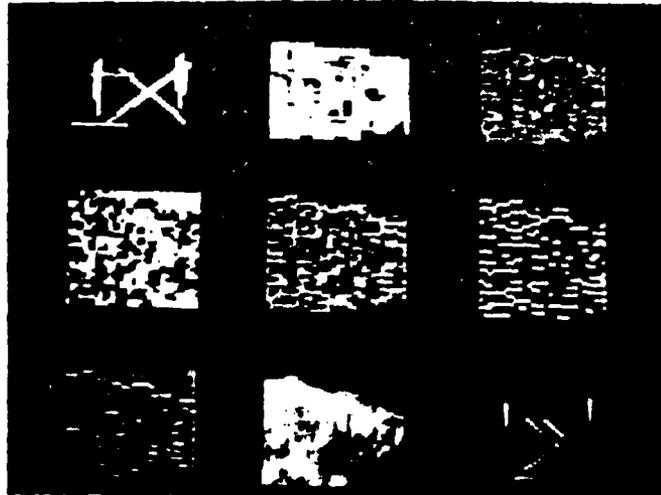
**Theses
Directed:**

K. Celik, "Focal Plane Signal Processing for Clutter Suppression and Target Detection in Infrared Images," Electrical Engineer's Thesis, June 1979.

D. Becker, "Microcomputer and Array Processor Based Implementation of Infrared Image Processing," Master's Thesis, March 1980.

W. Hess, "Multiple Microcomputer Implementation of Infrared Image Processing," Master's Thesis, June 1980.

Demonstration of End-to-end Processing of Infrared Images
For Detection of Very Dim Moving Targets
In Space Surveillance Applications



Simulated targets: 5 moving point targets 1 stationary track Target intensity 50 db below the mean of the Santa Cruz image	Infrared background clutter image: LWIR image taken from HCMM satellite Santa Cruz, California	Result of background clutter suppression by temporal and spatial filtering 3 frame temporal 3x3 spatial
Single frame result after the thresholding step 250 hits collected for a single frame	Results of the 3rd step of processing	
	Composite image of 13 frames: Positive signal Positive Composite	Composite image of 13 frames: Negative signal Negative Composite
Result of the 3rd step of processing: Final Composite image "Logic AND" combination of both Positive Compo- site and Negative Com- posite images	Results of the 4th step of processing	
	Declared tracks after the application of a "5 out of 10" spatial pattern test without using temporal informa- tion	Declared tracks after the application of a "5 out of 10" pattern test considering both spatial and temporal information

- IMPORTANT POINTS:**
1. Statistical temporal and spatial filters are effective in suppressing background clutter
 2. Target acquisition techniques using both spatial and temporal information are very effective such that a large number of hits can be collected in each frame (250 hits out of 1024 detectors)
 3. 4 of the 5 dim tracks (50 db below) can be detected together with 2 false tracks.

Fig. 1

Title: Analyses and Interpretation of White Cap, Surface Stress and Aerosol Data.

Investigators: K. L. Davidson, Associate Professor of Meteorology and Jorgen Hojstrup, Adjunct Professor of Meteorology

Sponsor: NPS Foundation Research Program

Objective: Perform joint analysis on aerosol size, distribution surface stress and "white-cap" data, obtained in Northeast Atlantic during JASIN-78, to formulate relationship between local aerosol production and "white-cap" coverage.

Summary: The role of local production on equilibrium aerosol distribution and procedures for estimating the production rate were sought from this rather unique data set which coupled aerosol, surface stress and white cap data. To do this, other factors influencing the equilibrium distributions had to be accounted for by suitable normalization. These factors were the relative humidity growth effect and surface layer transport intensities. Normalizations were performed on the observed aerosol distributions using accepted procedures (Fitzgerald, JAM, 1976; Lovett, Tellus 1979; Toba, Tellus, 1965) but yielded results with too large uncertainties to establish an empirical white-cap - number concentration relationship. The standard deviation of aerosol mass within an average wind category was larger than the change over the entire wind speed range. These results led to a conclusion that additional normalization is required before observed concentrations and white cap coverages can be correlated. Candidate parameters for this scaling are the depth of the atmospheric well mixed layer and the entrainment rate at the marine inversion.

Publications: A description of the results was presented to sponsors of our aerosol modeling-measurement work (NAVMAT, NAVAIR). They have agreed to support parallel measurements in the Gulf of Alaska during November and December 1980 in order to increase data base necessary for further analyses. ONR (Paul Twitchell,

Boston) solicited a proposal to extend analyses of available data and a proposal has been prepared and is being submitted.

Title: The Role of the Ocean in Extratropical Cyclone Evolution

Investigator: Russell L. Elsberry, Professor of Meteorology

Sponsor: NPS Foundation Research Program

Objective: The purpose of this research is to improve our understanding of the role of the air-sea fluxes in the extratropical cyclone evolution. A study of the cyclone and its environment will be carried out in a numerical model by systematically introducing the air-sea fluxes. Then the air-sea fluxes predicted in the atmospheric model will be used to drive an ocean model to determine the effect on the sea-surface temperature. The purpose will be to see if the ocean thermal structure changes are large enough to affect the air-sea fluxes in this or a subsequent storm. Finally, the atmosphere and ocean models will be run simultaneously to establish feedback mechanisms.

Summary: The approach in the atmospheric experiments is to systematically add or subtract physical processes in the numerical model. The resulting effect on the development, maintenance and movement of the extratropical cyclones over the ocean is being studied from the history files of the computer runs. It appears that the wavelength of the cyclones in the diabatic model runs is only half that found in the diabatic model results. Further results are expected from diagnostic interpretations of the atmospheric model results. The ocean model runs have not yet been completed. Future experiments will probably involve the use of a finer-resolution atmospheric model to study cyclogenesis in polar air streams over the ocean and over land.

Conference Presentations: S. A. Sandgathe and R. L. Elsberry, "An Unsolved Problem-What Factors Produce Ocean Cyclogenesis,". Paper accepted for Symposium on Current Problems of Weather Prediction, Vienna, Austria, June 1981.

R. L. Elsberry and S. A. Sandgathe, "The Effect of the Ocean on Medium Range Forecasting,". Paper accepted for Symposium on Current Problems of Weather Prediction, Vienna, Austria, June 1981.

Thesis
Directed:

S. A. Sandgathe, Ph.D. Thesis, in preparation.

Title: Numerical Simulation of Fronts over Eastern Asia

Investigators: R. T. Williams, Professor of Meteorology and L. Chou, Instructor of Meteorology

Sponsor: NPS Foundation Research Program

Objective: The objective of this research is to predict the structure of slow moving fronts associated with the early summer monsoon trough over eastern Asia, and to predict the spatial variation of the structure along the frontal zone.

Summary: This research uses an improved version of the numerical model which was developed by Cornelius, Glevy and Williams (1975). In this formulation, frontogenesis is forced by a horizontal wind field which contains deformation. The model includes a moisture prediction equation and condensation heating. Steady state solutions are achieved with the addition of horizontal and vertical diffusions of momentum, temperature and moisture. The new numerical model uses a staggered grid and stretched coordinates to improve accuracy and efficiency. A coordinate transformation is also used to allow surface frontal motion.

The numerical solutions show that condensation heating causes a much sharper front at upper levels when compared with dry experiments. However, surface frontal motion has very little effect on frontal structure when compared to atmospheric fronts. The numerical experiments show that the characteristics of the frontal structure are altered with changing Coriolis parameter, f . With a mid-latitude value of f under a typical potential temperature sounding, the frontal zone reveals strong horizontal temperature gradient and vertical tilt, which resembles a typical mid-latitude frontal zone. With a low-latitude value of f and a low-latitude potential temperature sounding, the frontal zone is changed to a state with weaker horizontal temperature gradient and

very little tilt in vertical, which resembles the inter-tropical convergence zone.

Publications:

R. T. Williams, L. Chou, and C. J. Cornelius, submitted to Journal of the Atmospheric Sciences.

L. Chou and R. T. Williams, "Effects of Condensation and Surface Motion on the Structure of Steady-State Fronts," presented at Fall Meeting of American Geophysical Union, San Francisco, CA, abstract published in Transactions, American Geophysical Union, 60, p. 840.

Title: Aerodynamic Stabilization of Gaseous Discharges

Investigators: Oscar Biblarz, Associate Professor of Aeronautics and J. L. Barto, LCDR, Instructor, U. S. Naval Academy

Sponsor: NPS Foundation Research Program

Objective: The main objective is to define practical aerodynamic means for stabilizing discharges of interest for electrical lasers, plasma-chemical devices, etc. Particular objectives are to test the effects of intense, low-frequency turbulence and to compare discharge geometries. This is part of a continuing program.

Summary: Turbulence generated in the shear region of mixing jets, one pulsed, has been examined. For the geometries and flows tested, the scheme was less effective than grid generated turbulence. Also, a new electrode configuration was designed and tested with grid-generated turbulence; results show the superiority of the pin-rack arrangement.

Publication J. L. Barto, "Study of Gas Dynamic Effects on Non-Equilibrium, High-Pressure, Electric Discharges," NPS Technical Report, NPS67-80-005, August 1980.

Conference Presentation J. L. Barto and O. Biblarz, "Gasdynamic Interactions in a Non-Uniform High Pressure Discharge," to be presented at the 33rd Gaseous Electronics Conference, Norman, Oklahoma, 7-10 October, 1980.

Thesis Directed: C. H. Davis, "Aerodynamic Stabilization of an Electric Discharge for Gas Lasers," Master's Thesis of Aeronautical Engineering and Electrical Engineering, September 1980.

Title: System Safety Software

Investigator: Donald M. Layton, Professor of Aeronautics

Sponsor: NPS Foundation Research Program

Objective: To investigate the analysis techniques that are available and in use for determining the System Safety parameters of software, and to ascertain if the techniques that are in use for analysis of hardware system safety are applicable.

Summary: An examination of several software system safety techniques was made and the generalized techniques were observed. It was determined that these techniques parallel the techniques used for hardware system safety analysis, and, in fact, are generally predicated on the premise that the only safety perturbation in software is one that directs or misdirects a hardware component. The software analysis techniques include a Bottom-to-Top method that is akin to Failure Mode and Effect Analysis, a Top-to-Bottom technique that is related to Fault Tree Analysis, and integrated method that combines some of the features of the other two.

Publication: A Naval Postgraduate School Report is being prepared and a paper is being submitted for the 1981 System Safety Society Conference.

Title: Particulate Behavior in Solid Propellant Rocket Motors

Investigator: David W. Netzer, Associate Professor of Aeronautics

Sponsor: NPS Foundation Research Program

Objective: To initiate a detailed and systematic determination of the effects of propellant composition and motor operating environment on the behavior of metallic particulates within solid propellant rocket motors.

Summary: Three experimental techniques were designed and constructed, and initial data were obtained. High speed motion picture studies of six specially formulated propellants were conducted using a windowed combustion bomb. Post-fire residue analysis was also conducted using a scanning electron microscope. Detailed propellant characteristics and filming resolution limits have been obtained for comparison and use with the other experimental techniques; holography of the combustion process in a two-dimensional, windowed motor and light scattering measurements to determine mean particulate size and concentrations.

Conference Presentation: E. Dubrov, V. D. Diloreto, and D. W. Netzer, "Particle Behavior in Solid Propellant Rockets," 17th JANNAF Combustion Meeting, NASA Langley Research Center, Hampton, VA 22-26 September 1980.

Thesis Directed: V. D. Diloreto, "An Experimental Study of Solid Propellant Deflagration Using High Speed Motion Pictures and Post-Fire Residue Analysis," Master's and Aeronautical Engineer's Thesis, June 1980.

Title: Multi-Stage Compressor Study

Investigator: R. P. Shreeve, Associate Professor of Aeronautics, Hans Zebner, Dipl. Ing., Aachen, W. Germany, and I. Moyle Exotech Ltd, Victoria, Australia

Sponsor: NPS Foundation Research Program

Objective: To reblade and instrument a large 3 stage axial compressor and carry out baseline measurements of the performance of newly designed "symmetrical" blading.

Summary: The compressor is 36 inches O.D. and has cylindrical flow path 7.2 inches high. All blades are individual and adjustable. In the present program, 240 cast-epoxy blades of new design were hand-finished, jigged, trimmed and one stage was assembled in the machine to a minimum tip clearance (0.020"). Traversing velocity, and fixed Kiel probes, and a new computer data acquisition system with Scanivalves were installed. Preliminary measurements of the stage performance were obtained at 1200 RPM. The work was documented in Tech Notes. from which a report will be issued. Following completion of the early measurements, an investigation of tip clearance and other 3-dim. flow effects is planned.

Publications: I. Moyle, and H. Zebner, "Multi-Stage Compressor Installation of Cast-Epoxy Blades," NPS Turbopropulsion Laboratory Tech. Note TPL TN 80-06, October 1980.

I. Moyle, "Multi-Stage Compressor-Data Acquisition Software," NPS Turbopropulsion Laboratory Tech. Note TPL TN 80-07, October 1980.

I. Moyle, "Multi-Stage Compressor-Circumferential Rake Design and Fabrication," NPS TPL TN 80-08, October 1980.

I. Moyle, "Multi-Stage Compressor-Initial Measurements with One Stage of Symmetrical Blading," NPS Turbopropulsion Laboratory, Tech. Note TPL TN 80-09, October 1980.

Title: Point Sur Cold Wedge

Investigator: Christopher N. K. Mooers, Professor, Chairman,
Department of Oceanography

Sponsor: NPS Foundation Research Program

Objective: Develop a predictive capability for the occurrence, three-dimensional structure, and evolution of coastal upwelling centers; e.g., the so-called "cold wedge" off Point Sur, CA. This predictive capability will use a combination of geophysical fluid dynamics principles, oceanic climatology for local upwelling events, bathymetry, surface wind analyses, and satellite remote sensing of sea surface temperature and perhaps other variables to infer the initiation, structure, and evolution of coastal upwelling centers.

Summary: The "cold wedge" off Point Sur is a thermal anomaly which is frequently noted in satellite IR data. It is known to be associated with oceanic fronts and eddies, coastal upwelling, submarine canyon topography, and the California Undercurrent, yet its dynamical nature has not been determined, nor has its generation, propagation or advection, and dissipation been modeled for purposes of ocean prediction. Such features are common off the west coast of continents. They have temperature anomalies of several degrees Celsius, and they are ca. 50 km wide and 300 m deep. Hence, they produce substantial anomalies in acoustic propagation, and a predictive knowledge of their development would contribute to the conduct of naval warfare.

The magnitude and nature of the processes associated with coastal upwelling centers are such that a several-year research program of field observation, analysis, and model development is required. The present research project is a pilot, repeated synoptic field study and analysis designed to provide the scientific basis for proposing a substantial observational, analysis, and modeling program to another potential sponsor; e.g., NASA, NSF, NORDA, or ONR.

A three-week pilot synoptic study was conducted in June 1980, principally from the R/V ACANIA. During the first and third weeks, a pair of XBT grids were occupied each week over a 90 km by 120 km coastal ocean domain centered on Sur Canyon. The 210 XBT casts were supplemented with 106 STD casts, continuous surface thermosalinograph traces, and other routine oceanographic and meteorological measurements. (During the second week, Dr. Traganza conducted an area study of the surface distribution of nutrients and organic substances off Point Sur). During the third week, R/V ACANIA's observations were supplemented by AXBT and ART data acquired from a Cl30 of the USCG and surface current data obtained from a SRI shorebased HF backscatter.

The pilot study was conducted during a period of sustained upwelling; in fact, there was an intense upwelling wind event during each of the three weeks. Nearshore sea surface temperatures in the upwelling center were 3 to 5 C cooler than 25 km offshore; occasionally, they dropped by as much as 1C/lkm across oceanic fronts. The surface area of the upwelling center increased with upwelling favorable winds. The upwelling center was manifested in thermal structure to a depth of at least 100 m and was clearly associated with bottom topography.

Publication:

An abstract has been submitted for a talk at the American Geophysical Union's Winter Annual Meeting in San Francisco, 6 to 10 December 1980. A manuscript is intended for submission to the Journal of Geophysical Research.

Thesis

Directed:

This winter a Ph.D dissertation proposal is being prepared by Mr. L. F. Breaker, NOAA/NESS to integrate this data set with satellite IR images, winds and coastal sea level time series, etc. An expanded and long-term proposal is planned for submission to NASA, NSF, NORDA, or ONR in the coming months.

Title: Acoustic Variability Experiment

Investigators: E. B. Thornton, Associate Professor of Oceanography and T. P. Stanton, Adjunct Professor of Oceanography

Sponsor: NPS Foundation Research Program

Objective: Investigation of the phase and amplitude modulation of sound propagating through the upper layers of the ocean.

Summary: A successful experiment was conducted 2-26 August 1979. Acoustic amplitude and phase fluctuations were measured across a 400 meter path. The sound source and hydrophones were mounted on the shelf adjacent to the Carmel canyon at a depth of 35 meters. The depth of the canyon at this location is approximately 180 meters. The experiment was designed to measure only the direct path of sound and not receive either the surface or bottom reflected sound. The acoustic source signal was a composite pulse consisting of a 0.5 millisecond 20 kHz pulse followed by 5 milliseconds of pseudo-random noise. The pseudo-random noise has acoustic energy in the band from 4 to 20 kHz.

The ocean temperature structure was measured both at the source and the receivers using horizontal and vertical thermistor arrays in order to determine the structure and correlation functions for the temperature microstructure. A two current meter array measured the current shear; thermistors are also mounted on the current meter packages to give long time series of the temperature.

Computer software has been developed to process the packed acoustic digital data and the Pulse Code Modulated environmental data. A paper is being prepared describing these results.

Publications: E. B. Thornton and T. P. Stanton, "Temperature Induced Phase and Amplitude Fluctuations of 20 kHz Pulses in the Upper Ocean," in preparation.

**Theses
Directed:**

M. Wakeman, "Acoustic Amplitude Fluctuations of 20 kHz Pulses in the Upper Ocean," in preparation.

C. Christensen, "Temperature Microstructure Profiles in Monterey Bay," Master's Thesis, December 1979.

Title: Optimum Design of Torsional Shafts Using Composite Materials

Investigator: Garret N. Vanderplaats, Associate Professor of Mechanical Engineering

Sponsor: NPS Foundation Research Program

Objective: To develop the analytic capability and FORTRAN program for the analysis of shafts made of multi-layered composite materials and couple this to a numerical optimization program to provide a general automated design capability.

Summary: The analytic capability has been developed to evaluate the response of hollow cylindrical shafts including synchronous whirl caused by mass imbalance. Failure modes which are evaluated include static and fatigue strength, maximum deflection, column buckling, axial and torsional cylinder buckling and critical speed. This has been programmed in FORTRAN and coupled to the optimization program COPES/CONMIN. The capability has been demonstrated with the design of steel shafts.

The constitutive equations have been formulated and programmed for shafts made of multilayered fiber composites and metal-composite combinations. Shafts have been designed for strength only and the remaining failure criteria (deflection, dynamic and buckling limits) are being incorporated into this general capability.

Research is continuing and is expected to result in a second Master's Thesis on the subject as well as a technical paper to be published in the open literature.

Thesis Directed: Virgilio S. Merced, "Drive Shaft Design Using Numerical Optimization," Master's Thesis, June 1980.

APPENDIX I

<u>Summary Title</u>	<u>Investigator</u>	<u>Type Funding</u>
COMPUTER SCIENCE		
Exploration of Performance Prediction Techniques for Advanced Computer Architecture	L. A. Cox	6.1
A Microprocessor Based Secure Archival Storage System	L. A. Cox R. R. Schell	6.1
Advanced Methods for Software Development	B. J. MacLennan	6.2
Towards a Unified View of Search Techniques	D. R. Smith	6.1
MATHEMATICS		
Investigation of Foutz Test for Goodness-of-Fit	R. Franke	6.1
Gaussian Stationary Markov Processes-Prediction Problems	T. Jayachandran	6.1
A Conjugate Gram Schmidt Algorithm in Constrained Minimization Problems	I. B. Russak	6.1
ADMINISTRATIVE SCIENCES		
Inindustry Structure and and Strategy: The Aerospace Industry	D. C. Boger	6.1
An Analysis of the Factors Affecting the Efficiency of Management Control Systems	K. J. Euske	6.1
Futures Planning in Organizations	R. Evered	6.1

<u>Summary Title</u>	<u>Investigator</u>	<u>Type Funding</u>
Strategic Acquisition/Re- sources Market Planning	D. V. Lamm R. Schill	6.2
Measuring the Efficiency and Effectiveness of Gov- ernment Activities	S. S. Liao	6.2
The First Years Out Study-- Career Transitions: Fa- cilitating Recruit Adaption	M. R. Louis	6.1
An Empirical Study of In- formation Gathering Behavior	N. R. Lyons	6.1
The Functions of Visual Mental Imagery	R. Weissinger-Baylon	6.1
Sequential Testing for Se- lection	R. A. Weitzman	6.1
DEFENSE RESOURCES MANAGEMENT EDUCATION CENTER		
Quantification of Values for Decisions with Multiple Objectives	P. D. Ivory	6.1
An Investigation of Local- ization and Tracking Pro- cedures	R. N. Forrest	6.2
Modeling the Influence of Information on the Progress of Conflict or Combat by Mathematical and Computa- tional Methods	D. P. Gaver	6.1
Enhancements to the LLARAN- DOM II Random Number Gen- erator Package	P. A. W. Lewis	6.1
NATIONAL SECURITY AFFAIRS		
Regional Cooperation in Southern Africa	M. Clough	6.2

<u>Summary Title</u>	<u>Investigator</u>	<u>Type Funding</u>
The Economic Impact of Arms Transfers to Less Developed Countries with an Application to the Internal Growth and Stability of Pre-Revolutionary Iran	R. Looney E. Laurance P. Frederiksen	6.2
Communist Countries and Africa	J. Valenta W. Potter	6.1
Soviet Decisionmaking for National Security	J. Valenta D. Albright	6.1
French and Soviet Perspectives on Theater Nuclear Policy and Arms Control	D. S. Yost	6.1
PHYSICS AND CHEMISTRY		
Classical Trajectory Studies of Low Energy Ion Impact Mechanisms on Clean and Reacted Single Crystal Surface	D. E. Harrison B. J. Garrison N. Winograd	6.1
Spectroscopic Data Center Compilation of Atomic Energy Levels	R. L. Kelly	6.1
Plasma Surface Interaction	F. Schwirzke	6.1
Underwater Acoustic Noise Due to Surf Phenomena	O. B. Wilson, Jr. S. N. Wolf F. Ingenito	6.1
ELECTRICAL ENGINEERING		
Millimeter Wave Transmission Media	J. B. Knorr	6.1
Magnetic Monitoring at Chews Ridge	P. H. Moose O. Heinz E. Crittenden	6.1
Radar Identification Via Time-Domain Scattering Signatures	M. Morgan M. Hamid	6.2

<u>Summary Title</u>	<u>Investigator</u>	<u>Type Funding</u>
Enhancement of Computing Power of 16 Bit Microcomputer by Using Microcomputer Compatible Array Processor	T. F. Tao	6.1
METEOROLOGY		
Analyses and Interpretation of White Cap, Surface Stress and Aerosol Data	K. L. Davidson J. Hostrup	6.1
The Role of the Ocean in Extratropical Cyclone Evolution	R. L. Elsberry	6.1
Numerical Simulation of Fronts Over Eastern Asia	R. T. Williams L. Chou	6.1
AERONAUTICS		
Aerodynamic Stabilization of Gaseous Discharges	O. Biblarz J. L. Barto	6.1
System Safety Software	D. M. Layton	6.2
Particulate Behavior in Solid Propellant Rocket Motors	D. W. Netzer	6.1
Multi-Stage Compressor Study II	R. P. Shreeve I. Moyle	6.2
OCEANOGRAPHY		
Point Sur Cold Wedge	C. N. K. Mooers	6.1
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MECHANICAL ENGINEERING		
Optimum Design of Torsional Shafts Using Composite Materials	G. Vanderplaats	6.2

PROGRAM REVIEW

The Foundation Research Program is monitored by the Pasadena Branch Office of the Office of Naval Research.

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