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SUMMARY OF RESEARCH ACTIVITIES ACADEMIC DEPARTMENTS 1977-1978.(U)  
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SUMMARY OF  
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ACADEMIC  
DEPARTMENTS

1977-1978

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# LEVEL II

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SUMMARY  
OF  
RESEARCH ACTIVITIES  
1977 - 1978

AD - A046845

COMPILED AND EDITED  
BY  
PROFESSOR WILSON L. HEFLIN  
ENGLISH DEPARTMENT

SEPTEMBER 1978

UNITED STATES NAVAL ACADEMY  
ANNAPOLIS, MARYLAND  
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## FOREWORD


The academic excellence of an educational institution is measured by the achievements of its faculty in teaching, research, and related scholarly endeavors. It is the policy of the Naval Academy to provide and maintain an environment in which research activities that contribute to the professional growth of the faculty and outstanding midshipmen may flourish.

The research activities of the faculty range from very applied cooperative studies with the Navy research and development community to very fundamental investigations concerned with extending the frontiers of knowledge. The broad scope of research described in this annual report reflects the interests and expertise of the participating faculty and midshipmen, as well as the availability of laboratory, library and computer facilities. *(continues on p. iv)*

This publication was compiled to acquaint the reader with faculty and midshipmen research efforts being done behind the classroom scene. Research results are published in manuscripts, reports, and prestigious journals as well as presented at important professional meetings and conferences. In addition to their teaching and research, the faculty contribute to their profession through participation in professional societies and consulting activities. This publication contains summaries of completed and on-going faculty projects, midshipmen research course projects including the Trident Scholar Program, and lists of presentations and publications. The work reported on was conducted during the period 1 July 1977 through 30 June 1978.

External support continues to increase significantly reaching a level of one million dollars in Fiscal Year 1978. This is undoubtedly due to the additional opportunities provided by new laboratories in the Engineering Studies Complex and the initiative of the well-qualified civilian and military members of the faculty. It is important to acknowledge the strong and continuous support provided by the Chief of Naval Research, Chief of Naval Development and the numerous activities of the Naval Material Command, without which such progress could not be possible.

  
BRUCE M. DAVIDSON  
Academic Dean

  
RICHARD D. MATHIEU  
Director of Research

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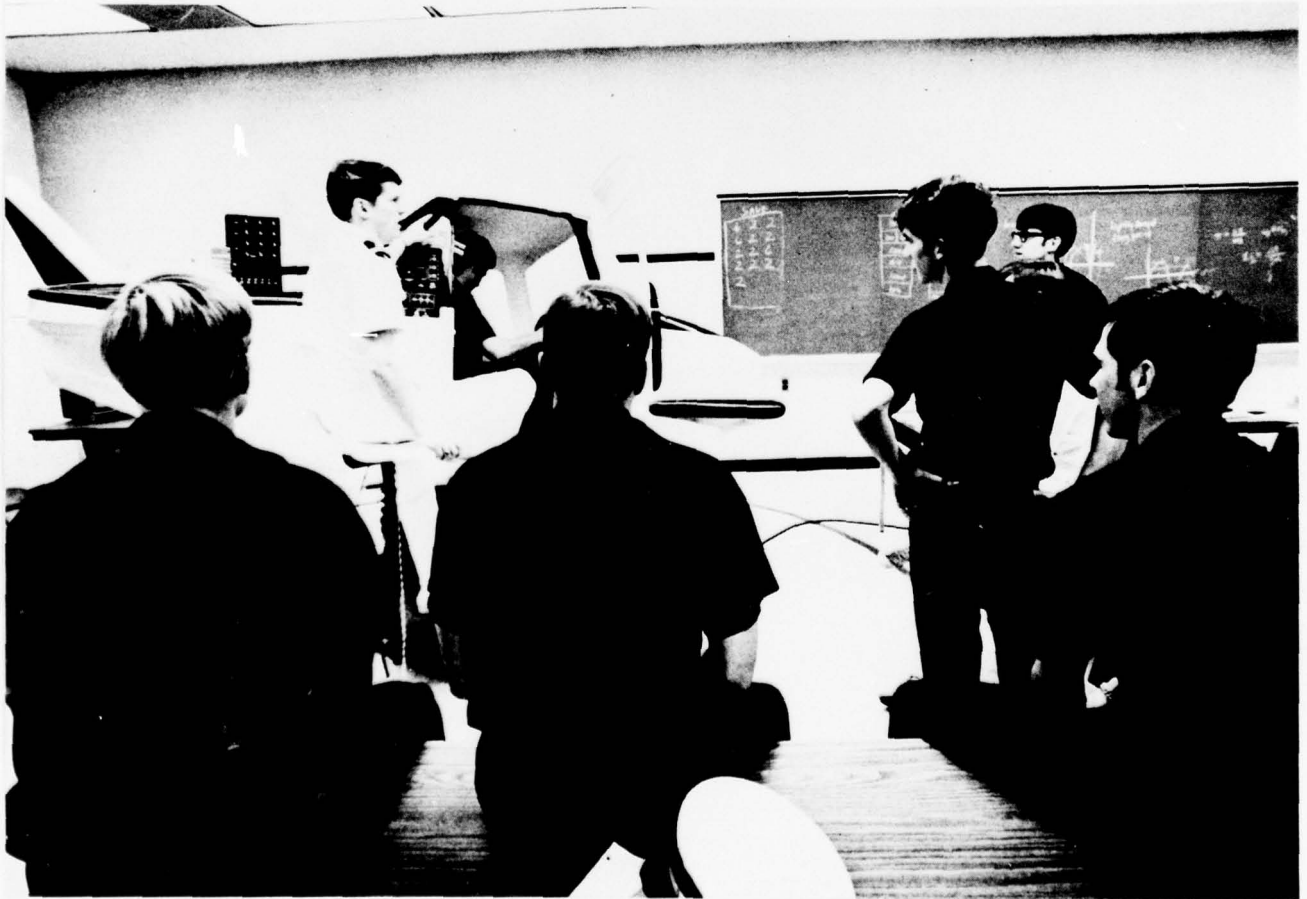
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DIVISION OF  
ENGINEERING AND WEAPONS





## AEROSPACE ENGINEERING DEPARTMENT

*Commander Marle D. Hewett, USN, Chairman*

The enclosed annual research summary for this Department reveals a deep interest by Department faculty over a very wide range of subjects. Nearly every member of the Department's twelve-man faculty is involved in gaining knowledge on some frontier--from the thermodynamic cycle of a modified internal combustion engine to seeding effects on condensation of water vapor in aerodynamic nozzles. This intense research effort provides a rich atmosphere for learning and challenge. Consequently, faculty members are dynamic and up-to-date in their respective fields. As a result, the undergraduate instruction they provide is also up-to-date, interesting to the student, dynamic, and relevant.

Midshipmen are very actively involved in the research efforts of the Department. Through the Trident Scholar Program and research course work, they explore limited portions of a faculty member's larger research effort or take on small independent study. Research adds spice to the teaching environment and rare excitement of discovery to those accepting the challenge.

The most noteworthy undertaking of the Department this year was the acquisition of the XR-5 48-foot Experimental Surface Effect Ship. Department personnel will refurbish the vehicle and conduct SES research with it for the next ten years, with the guidance and support of the Naval Sea Systems Command. It is a challenging and exciting task with many possibilities for imaginative work.

Work is continuing on the Naval Academy Heat Balanced Engine. The Office of Naval Research continues to provide support for research into the NAHBE thermodynamic cycle.

The Department was particularly fortunate this year to have as its Naval Air Systems Command Research Professor, Sir Frank Whittle, the father of the jet engine. Sir Frank taught Propulsion, became the first Director of our new Propulsion Laboratory, and conducted a major research effort in mechanical boundary layer control. We have all benefited immensely from his presence and grown from the experience.

All in all, it has been an active and exciting year in Aerospace Engineering.

\*\*\*\*\*

## DEVELOPMENT OF COMPOSITE FLYWHEELS FOR ENERGY STORAGE AND GYROSCOPIC CONTROLS

Researcher: Assistant Professor William J. Bagaria

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The U. S. Navy has numerous applications of high-speed flywheels. These include energy storage, such as past use of flywheels to drive torpedoes; and gyroscopic control, such as guidance systems in ships, submarines, aircraft, and missiles. The limited amount of space available in most applications requires the use of small, high RPM flywheels. These requirements can be met by constructing the flywheels from directional, high strength, fiber-composite tapes.

The technical objective of this project is to design, analyze, and test the most promising methods of construction for composite flywheels. The approach to the project is:

1. Analysis of composite flywheels,
2. Detailed design of the flywheels,
3. Design of the test equipment,
4. Construction of the flywheels and test equipment,
5. Evaluation and comparison tests of the flywheels.

Part 1 was completed and reported on by Dr. Robert A. McCoy. Parts 2 and 3 were completed and reported on by Dr. William J. Bagaria. Materials have been received and construction of one and one-half flywheels (of three) has been completed. A response from the Naval Air Propulsion Center (NAPC) has been received. This response indicated that NAPC will test the three flywheels at a cost of \$1,000. NAPC indicated that they have experienced critical speed problems in testing composite rotors and recommended that an analysis of this problem be conducted before the flywheels are tested. This analysis has been completed and a general purpose computer program has been written and implemented that determines the flywheel critical speeds.

Future research is being undertaken for the completion of parts 4 and 5.

\*\*\*\*\*

EVALUATION OF ADVANCED NAVAL VEHICLES CONCEPTS

Researcher: Professor Bernard H. Carson

Sponsor: Naval Air Development Center

This project consisted of numerous sub-tasks in the area of advanced vehicle evolution, done for the Naval Air Systems Command. Preliminary evaluations were undertaken of several novel concepts which included the span loader, the wing-in-ground effect, and the induction wing vehicle.

\*\*\*\*\*

MODIFIED INTERNAL COMBUSTION ENGINE PROJECT (NAHBE)

Researchers: Professor Andrew A. Pouring, Professor Bruce H. Rankin (Naval Systems Engineering Department), Assistant Professor Eugene L. Keating (Mechanical Engineering Department), and Richard F. Blaser (Contractor)

Sponsors: Naval Material Command (Code MAT-03Z) and Office of Naval Research (Code ONR-473)

The principal goal of this project is the refinement of and development of basic understanding of the new process of combustion in internal combustion engines with pressure exchange. The standard internal combustion engine piston is modified with a cap creating a secondary chamber. Modifications to carburetion, combined with this piston modification, result in engine operation on a new, more efficient thermodynamic cycle. A number of engines have been modified.

The engines to date have given up to 35 percent improvement in fuel economy at low RPM, extended the range of internal combustion engine operation from operation at no output to full output, greatly reduced exhaust emission, and have been operated on many fuels.

Research has been conducted on both spark ignition and compression ignition engines. The research effort at the Naval Academy is devoted primarily to investigating and explaining the thermodynamic cycle on which the engine operates. Avco Lycoming is pursuing NAHBE engine development.

\*\*\*\*\*

B-SPLINE CURVES AND SURFACES FOR SHIP HULL DEFINITION

Researcher: Professor David F. Rogers

Sponsor: Naval Ship Engineering Center

The suitability of B-spline curves and surfaces for ship hull definition was investigated. Comparisons were made with other curve and surface definition methods and a report was published on the results. The concepts were implemented on an Evans and Sutherland Picture System supported by a PDP 11/45 and a Xynetics Model 1200 flatbed plotter.

\*\*\*\*\*

THRUST AUGMENTORS

Researcher: Assistant Professor Joseph F. Sladky, Jr.

Sponsor: Naval Air Systems Command and Naval Sea Systems Command

The 1977-1978 academic year focused on the continued development of the crypto-steady thrust augmentor project. Special emphasis was placed on attaining comprehensive instrumentation and automated data reduction. Structural failure in the supporting assembly required a redesign, and a new air-bearing supported thrust assembly was developed. A series of shroud profiles was developed and the ducts are now being fabricated. Preliminary tests have indicated satisfactory operation of the equipment and its instrumentation.

It is planned to complete the testing phase of the project in the summer of 1978. There are, however, several interesting aspects or possibilities discovered in the present work that should be investigated in the future. Among the most promising is a "core jet" configuration in the region of the spinner after-body.

\*\*\*\*\*

WING BOUNDARY LAYER IMPROVEMENT

Researchers: Research Professor Sir Frank Whittle and Midshipman 1/C James D. Oliver

Sponsor: Naval Air Systems Command

The use of mechanical boundary layer control, a method whereby boundary layer is energized through contact with a moving surface, remains an acutely under-researched field of study. The purpose of this project was to investigate the use of rotating cylinders as an artificial replacement for that part of an airfoil aft of the point of

maximum thickness/chord ratio. Since the majority of lift is developed over the first half of the chord, the remaining half has the main purpose of reducing the profile drag, but at the expense of considerable skin-friction drag. Two counter-rotating cylinders deflect flow streamlines and achieve the same objective of minimizing wake turbulence with much reduced skin friction drag. In addition, overall chord length is reduced, allowing larger lifting surfaces on the same airframe. Finally, since at a positive angle of attack the upper cylinder rotates faster than the lower one, additional lift is generated by the "Magnus Effect." A scale model of the system was built and tested alongside a conventional airfoil in the Naval Academy's wind tunnel. Encouraging results were obtained, tending to verify the theoretical expectations.

\*\*\*\*\*

FUEL DELIVERY SYSTEMS FOR NAHBE-CLASS HEAT BALANCED ENGINES

Researcher: Midshipman 1/C Steven W. Petri

Advisers: Professor Andrew A. Pouring, Assistant Professor Eugene L. Keating (Mechanical Engineering Department), and Professor Bruce H. Rankin (Naval Systems Engineering Department)

Sponsor: Trident Scholar Program

Conventional fuel systems have proven inadequate for the NAHBE engine. This project initiated the design and development of suitable fuel delivery systems. Potential systems considered included aspirating, electronic, and mechanical fuel delivery systems used in conjunction with both two- and four-stroke cycles in single- and multi-cylinder engine configurations. It is anticipated that a direct result of this design effort will be the conversion of the Navy's P-250 pump from a gasoline-driven engine to a NAHBE diesel-fueled spark engine. This will obviate the need for Navy vessels to carry gasoline onboard and allow them to rely upon the less volatile and less hazardous diesel fuel.

This project was a total, multi-disciplinary engineering experience involving combustion, electronics, fluid mechanics, materials science, mechanics, and design. An engineering assessment of the operational features of proposed designs was based upon both theoretical work and laboratory experimentation/testing.

\*\*\*\*\*

VISCOUS ENTRAINMENT OF MASS ENERGY IN FLUID DYNAMIC ENERGY SEPARATION

Researcher: Assistant Professor David R. Sobel

A two-dimensional jet upon impingement on a wall will bifurcate into two streams. The emerging streams will have different energy levels if the jet source is moving parallel to the impingement surface. This is the mechanism by which the Foa Energy Separator divides an initially homogeneous stream of fluid into two streams having energy levels one higher and the other lower than that of the original stream.

This study deals with the viscous interaction between the jet and the translating impingement surface, and with the adverse effect that the viscous entrainment of mass and energy from the high-energy to the low-energy stream may have on the performance of the Energy Separator. The solution requires the development of an implicit, iterative finite-difference scheme, and its essential validity is verified both experimentally and by application to special cases for which the solutions are available.

Application of the procedure to a representative geometry and operating condition reveals that the effect of viscosity on the performance of the Energy Separator is negligible.

\*\*\*\*\*

SURVEY OF HIGH-SPEED SKIN FRICTION MEASUREMENT TECHNIQUES

Researcher: Midshipman 1/C Joseph A. Alvite

Adviser: Professor Bernard H. Carson

While viscous skin friction is an area studied theoretically in several aerospace engineering courses, no practical demonstrations of this have yet been developed here. With the acquisition of the new Aerospace Engineering high-speed laboratory, it was thought to be a valuable and informative exercise for the student to review present methodology in the area of high-speed skin friction measuring techniques, and this was the basis for this study. The study culminated in a report which included a comprehensive literature search, a survey of current techniques, and recommendations for apparatus which could be built locally, for the purpose of conducting such measurements.

\*\*\*\*\*

CANARD CONFIGURATION RESEARCH AND DESIGN

Researchers: Midshipmen 1/C William J. Beary and Gregory R. Long

Adviser: Professor Bernard H. Carson

The canard aircraft configuration, in which the horizontal stabilizer is placed ahead of the main lifting surface, has been proposed various times in the past, but designs have usually failed to produce significant improvements due to unanticipated flow interactions and stability problems. Of late, several small but highly successful canard designs have been brought forth, and this study was a comprehensive attempt to evaluate the canard configuration in its totality. Both theoretical work and experimental studies, conducted in a smoke tunnel, were included. It was found that the canard configuration, if carefully designed, is a viable concept, but its success is considerably more dependent on center-of-gravity than the conventional configuration.

\*\*\*\*\*

SUPERSONIC WIND TUNNEL CALIBRATIONS

Researcher: Midshipman 1/C Darrell L. Cofsky

Adviser: Professor Andrew A. Pouring

The Aerospace Engineering Department's new 6" x 6" supersonic wind tunnel required calibration before being accepted by the Naval Academy for use in the laboratory. Midshipman Cofsky conducted the calibration at specified nozzle settings, using schlieren techniques.

\*\*\*\*\*

GAT-1 TRAINER VARIABLE STABILITY

Researcher: Midshipman 1/C James D. Gafford

Adviser: Commander Marle D. Hewett

The purpose of this project was to increase the variable stability capability of the Department's GAT-1 Trainer by interfacing it with the Hybrid Computer belonging to Systems Engineering. The interface allows the hybrid to be used for storage of all stability derivatives as a function of Mach Number and angle of attack and feed these derivatives to the GAT-1 in real time.

\*\*\*\*\*

STUDIES IN LIGHTER-THAN-AIR TECHNOLOGY

Researcher: Midshipman 1/C Walter Mac Gray

Adviser: Professor Bernard H. Carson

A survey of prior and present efforts in the lighter-than-air field was undertaken. This was basically a tutorial, self-study effort.

\*\*\*\*\*

FREE-FEATHERING ROTOR

Researcher: Midshipman 1/C Donald A. Kuntz

Adviser: Associate Professor Vadym V. Utgoff

Midshipman Kuntz' project involved designing a free-feathering rotor. In a free-feathering rotor, rotor blades are restrained from flapping; they are held at some specific flap-angle which can be varied, and are free to rotate about the pitch axis. If the pitch axis is forward of the mass center, for any positive flap angle there will be a component of centrifugal force which will produce a positive blade-pitching moment tending to increase the blade angle of attack. If the pitch axis is also forward of the aerodynamic center, a positive angle of attack will produce a negative aerodynamic pitching-moment. Thus, blade pitch is determined by a balance between the centrifugal pitching-moment and the aerodynamic pitching-moment. Collective pitch is therefore governed by the coning angle selected; and cyclic pitch changes can be effected by cyclic variation of the flap angle.

Since the thrust of the free-feathering rotor is essentially a function of the imposed flap angle and rotational speed only, it is substantially independent of axial flight velocity. It also requires no teetering hinge to accommodate in-plane motion since blade lift is always balanced by centrifugal force.

\*\*\*\*\*

NON-STEADY GASDYNAMICS

Researcher: Midshipman 1/C James W. McClean

Adviser: Professor Andrew A. Pouring

The methods of non-steady gasdynamics were investigated analytically, including detonation-deflagration concepts. The analytical work presented in M. Pendale's doctoral dissertation on NAHBE combustion was verified.

\*\*\*\*\*

COMBUSTION FUEL RESEARCH-NAHBE

Researcher: Midshipman 1/C James McClelland

Adviser: Professor Andrew A. Pouring

The multi-fuel performance of the NAHBE engine was investigated on the existing CFR engine. Gasoline-alcohol mixtures were tested in various combinations for performance, combustibility, and suitability.

\*\*\*\*\*

DESIGN OF A MANPOWERED AIRCRAFT

Researcher: Midshipman 1/C Thomas D. McLeod

Adviser: Commander Marle D. Hewett

The purpose of this project was to design a manpowered aircraft for sport purposes. The design included configuration, structure, a complete preliminary engineering analysis including performance, stability and control, and structural analysis.

\*\*\*\*\*

SAILING CENTER WIND TUNNEL TESTING

Researcher: Midshipman 1/C Scott S. Pihlaja

Adviser: Professor Andrew A. Pouring

This project consisted of testing the Sailing Center model in a sub-sonic wind tunnel in a non-uniform flow. Results showed that, with windows broken or removed, the Sailing Center roof can withstand up to 70 knots of wind from the northeast before becoming airborne.

\*\*\*\*\*

SINGLE-BLADED TORQUELESS HELICOPTER

Researcher: Midshipman 1/C Robert R. Romaine

Adviser: Associate Professor Vadym V. Utgoff

This was a follow-on project of Midshipman Martinus Klijn's project; the helicopter of his design has two serious problems which needed to be solved. The power transfer system from the engine to the counterrotating props did not work and needed to be redesigned. There was also the problem of a throttle on a rotating engine. After overcoming these difficulties, testing began in the Rotor Lab for stability and design characteristics and continued to testing outdoors on a moving platform for further stability observations.

\*\*\*\*\*

SUPERSONIC WIND TUNNEL CONSTRUCTION AND TEST

Researcher: Midshipman 1/C Walter G. Sharp

Adviser: Professor Andrew A. Pouring

A simple wooden supersonic wind tunnel design given in an AIAA Student Journal as a student project was fabricated and tested for performance by Midshipman Sharp. He sized the tunnel, interfaced it to the existing air supply, and tested the tunnel for performance.

\*\*\*\*\*

## SELF-GOVERNING DARRIEUS WINDMILL

Researcher: Midshipman 2/C Mark Tempestilli

Adviser: Associate Professor Vadym V. Utgoff

The Darrieus rotor is a vertical axis windmill consisting of semi-circular blades with an airfoil cross-section. This project used flexible blades to form a catenary, with top and bottom ends of the blades separated by a compression spring. As rotational speed increased, centrifugal force forced the centers of the blades away from the axis of rotation which changed the shape of the catenary in such a way as to reduce the torque. The compression spring then forced the ends of the blades apart, bringing the centers closer to the axis of rotation which increased the aerodynamic torque. Rotational speed changes with changes in wind velocity were greatly reduced, i.e., the rotor was substantially self-governing.

The project consisted of an analysis of the concept and the construction of a small-scale test apparatus.

\*\*\*\*\*

## STABILITY AUGMENTATION FOR A VSTOL AIRCRAFT

Researcher: Midshipman 2/C Robert V. Walters

Adviser: Commander Marle D. Hewett

The purpose of this project was to study aircraft stability and control and outline a stability augmentation study for a VSTOL aircraft to be pursued by this midshipman as a Trident Scholar research project next year. Midshipman Walters' project has been approved by the Superintendent.

To date, a suitable project has been formulated and research has begun. The project involves redesigning the Stability Augmentation System of the AV-8A Harrier for improved and safer handling qualities. A six-degree-of-freedom computer model of the AV-8A Harrier in VSTOL flight has been obtained from NADC, Warminster, and is being installed on the U. S. Naval Academy computer and the Weapons and Systems Engineering Department hybrid computer. Once the program is operational, the Stability Augmentation System will be incorporated and research into its improvement will commence.

\*\*\*\*\*

PETRI, Steven W., Midshipman 1/C, "Fuel Systems for Heat Balanced Internal Combustion Engines," Trident Scholar Project Report Number 94, (1978), U. S. Naval Academy, Annapolis.

A general approach to the design and selection of a fuel delivery system for heat balanced engines has been developed. Using this approach a particular fuel delivery system compatible with a specific two-stroke heat balanced engine has been selected, fabricated, and installed. An engine testing facility and simple model formulated for the engine have been established and a complete test program outlined.

\*\*\*\*\*

POURING, Andrew A., Professor, "The Kinetics of Evolution of Water Vapor Clusters in Air," Symposium Volume, Levich Physical Chemistry and Hydrodynamics Conference, Oxford, England, July 1977.

The kinetic theory of cluster formation in a condensing gas proposed by Buckle attempts to calculate the course of homogeneous condensation from molecular rather than thermodynamic precepts. Here it is applied to the rapid non-equilibrium expansion of atmospheric water vapor in air. A method established for demonstrating the validity of this theory originally proposed for a mono-molecular gas, in the case of a complicated species such as water vapor is summarized. Cluster concentration in the temperature range 210-295°K and the vapor pressure are calculated throughout the collapse of a super-saturated metastable vapor.

An effective molecular pair interaction energy and nearest neighbor coordination number is found based on the classical zero-point enthalpy of sublimation of 273°K. The internal energy redistribution frequency results from close matching of the experimental pressure distribution. For the water vapor dimer an equilibrium constant of  $4.0 \times 10^{-21} (\text{cm}^{-3})$  is found at 273°K compared to  $3.1 \times 10^{-21} (\text{cm}^{-3})$  obtained from Keyes data.

Two models for water vapor clusters result which are given in terms of number of nearest neighbors, pair interaction energy per molecule (2.9kcal/mol at 273°K) and possible structure on a cluster by cluster basis for a classical hard sphere model and for a model approximating a Pauling type clathrate.

\*\*\*\*\*

ROGERS, David F., Professor, "B-Spline Curves and Surfaces for Ship Hull Definition," EW Report 10-77, U. S. Naval Academy, Annapolis, October 1977.

B-spline curves and surfaces and their suitability for ship hull surface definition are discussed. A comparison with other curve and surface definition methods, e.g., cubic splines, Bezier curves, parabolic blending, is given. Their use both for ab initio curve and surface generation and for fitting existing offset data is discussed. Comparisons of the data storage requirements are made. The utilization of these concepts in an interactive design program implemented on an Evans and Sutherland Picture System supported by a PDP 11/45 and a Xynetics Model 1200 flatbed plotter are discussed. Initial efforts in generating numerical control tapes from the resulting data base and the manufacture of towing tank models are discussed. A demonstration of this program and the model manufacturing technique is given.

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PRESENTATIONS

AEROSPACE ENGINEERING DEPARTMENT

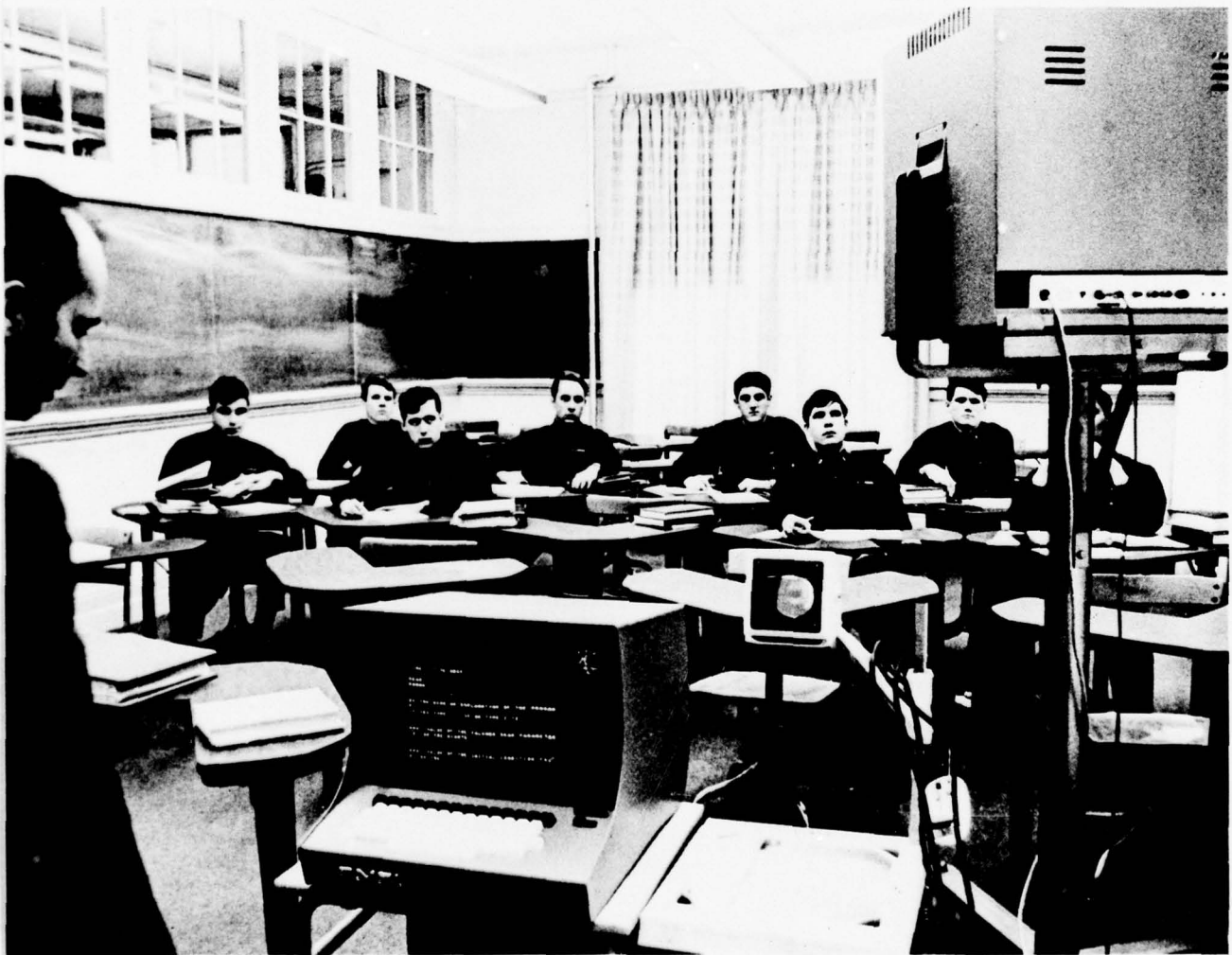
CARSON, Bernard H., Professor, "Experimental Observations of the Two-Dimensional, Power Augmented RAM Wing Operated Statically Over Water," 6th AIAA/SNAME Advanced Marine Vehicles Conference, San Diego, California, 17-19 April 1978.

\*\*\*\*\*

POURING, Andrew A., Professor, "The Kinetics of Evolution of Water Vapor Clusters in Air," Levich Physical Chemistry and Hydrodynamics Conference, Oxford, England, July 1977.

\*\*\*\*\*

ROGERS, David F., "B-Spline Curves and Surfaces for Ship Hull Definition," First International SNAME Symposium on Computer-Aided Hull Surface Definition, U. S. Naval Academy, Annapolis, September 1977.



## ELECTRICAL ENGINEERING DEPARTMENT

*Professor Francis Joseph Eberhardt, Chairman*

The research activities of the Department of Electrical Engineering continue to cover a wide range of interests--from amorphous semiconductors to the signal processing of acoustic signatures that are related to a non-invasive diagnostic for arterial disease. There is still interest in digital technology, particularly in the applications of microprocessors. Four faculty members have been active in various microprocessor projects, some of them related to finding the proper role and utilization of this tool in the educational process. Included are techniques for modernization of the Central Signal Distribution System to incorporate microprocessor control.

There were several midshipman independent research projects carried out this year. For the future, an increase in these is expected and the Department will have a Trident Scholar in Academic Year 1978-1979. The Trident Scholar project involves amorphous semiconductors switching properties. Almost all other midshipman projects are digital communications, digital filtering, and so on.

Research in the Department of Electrical Engineering serves three purposes: it supports continuing development of the faculty; it provides the important element of applied engineering for midshipmen who participate in projects; and it contributes new knowledge to the disciplines. The second of these purposes is the most important at the Naval Academy. Research must provide the basis for a strong undergraduate program. Therefore, in addition to advancing the frontiers of their research areas, faculty members are committed to maintaining dynamic and challenging projects for midshipmen who choose to specialize in electrical engineering. Participating midshipmen have the opportunity to engage, with faculty, in unstructured scientific effort of a wide variety. Thus, they are exposed to some of the techniques applied to the solution of practical engineering problems. Research activity provides midshipmen the opportunity to learn how the engineering community responds to the ever-expanding needs of the service.

\*\*\*\*\*

BISTABLE SWITCHING IN AMORPHOUS  $\text{Bi}_2\text{O}_3$  FILMS

Researcher: Assistant Professor Jake H. Halford

Sponsor: Naval Electronics Systems Command

A technique for depositing amorphous  $\text{Bi}_2\text{O}_3$  films has been developed which is mainly responsible for switching characteristics. These devices have potential use as nonvolatile memory elements because of bistable conduction modes. The objective of this project was to study the actual switching mechanisms in the amorphous films and to determine the effects of the deposition process on switching times.

Development of amorphous bismuth trioxide films has been a slow process. Care must be taken in the evaporation process or optically dark and highly conductive films result which are bismuth rich. The source of the difficulty is the fact that  $\text{Bi}_2\text{O}_3$  decomposes during evaporation, resulting in a bismuth rich source. Rapid controlled evaporation of fresh  $\text{Bi}_2\text{O}_3$  powder is the only means of producing clear, amorphous  $\text{Bi}_2\text{O}_3$  films.

To produce the clear amorphous  $\text{Bi}_2\text{O}_3$  films, a Kronos Digital Film Thickness Monitor was installed so that film thickness and film evaporation rate could be recorded simultaneously. Deposition rate is of critical importance because of film decomposition. It was found that film density also changed as films were deposited so a standard deposition sequence had to be followed for each run to accurately record film thickness. Thin 800A gold electrodes were used to make the Au- $\text{Bi}_2\text{O}_3$ -Au cross film devices. Bismuth trioxide film thickness was approximately 5000A.

Measurement of the ratio of device OFF to ON state resistance was 600:1. Scanning and electron microscopy analysis revealed that switching is caused by localized conducting filaments (radius = .88  $\mu\text{m}$ ) formed in the amorphous  $\text{Bi}_2\text{O}_3$  films. The conducting filaments caused "bumps" to appear on the top gold electrode. An amorphous to  $\delta\text{-Bi}_2\text{O}_3$  phase transition occurs in the filamentary region that is reversible upon application of a high current pulse. The  $\delta\text{-Bi}_2\text{O}_3$  phase has a much higher conductivity than the amorphous  $\text{Bi}_2\text{O}_3$  phase. An "electrothermal filamentary computer model" has been studied and experimental data was used to predict filament conductivity, temperature and phase transitions in the filaments.

Slow switching measurements made on these films proved that the amorphous films had bistable conduction states and that the films could repeatedly switch from a low conductivity state to a high conductivity state without permanent damage to the device.

\*\*\*\*\*

DEVELOPMENT OF AN UNDERGRADUATE LEVEL MICROPROCESSOR LABORATORY

Researcher: Research Professor Richard L. Martin

Sponsor: Naval Electronics Systems Command

The principal goal of the NAVELEX Research Professor has been the development of an undergraduate level microprocessor laboratory facility useful for both Electrical Engineering majors and for majors in other technical fields. The laboratory is currently being used in support of the Electrical Engineering Logic Design Track and in the Electrical Engineering courses supporting the General Engineering major.

A series of four seminars, each consisting of a short lecture followed by a hands-on laboratory, was developed and given for the other EE faculty. The series was then repeated for faculty members in their technical departments. Hands-on microprocessor workshops were presented at the Mid-Atlantic Section meeting of the American Society for Engineering Education in New York and also at the Annual Meeting in Vancouver, British Columbia. These workshops were in cooperation with the Weapons and Systems Engineering Department.

In addition to using the microprocessor trainers for basic experiments, outlines have been developed for several more elaborate projects using the trainers for both control and computing. These projects include simple motor control, control of an X-Y plotter, a differential equation solver, and a polynomial computer.

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NONINVASIVE DETERMINATION OF THE SEVERITY OF AORTIC STENOSIS

Researcher: Associate Professor Antal A. Sarkady

Sponsor: Children's Hospital, National Medical Center, Washington, D. C.

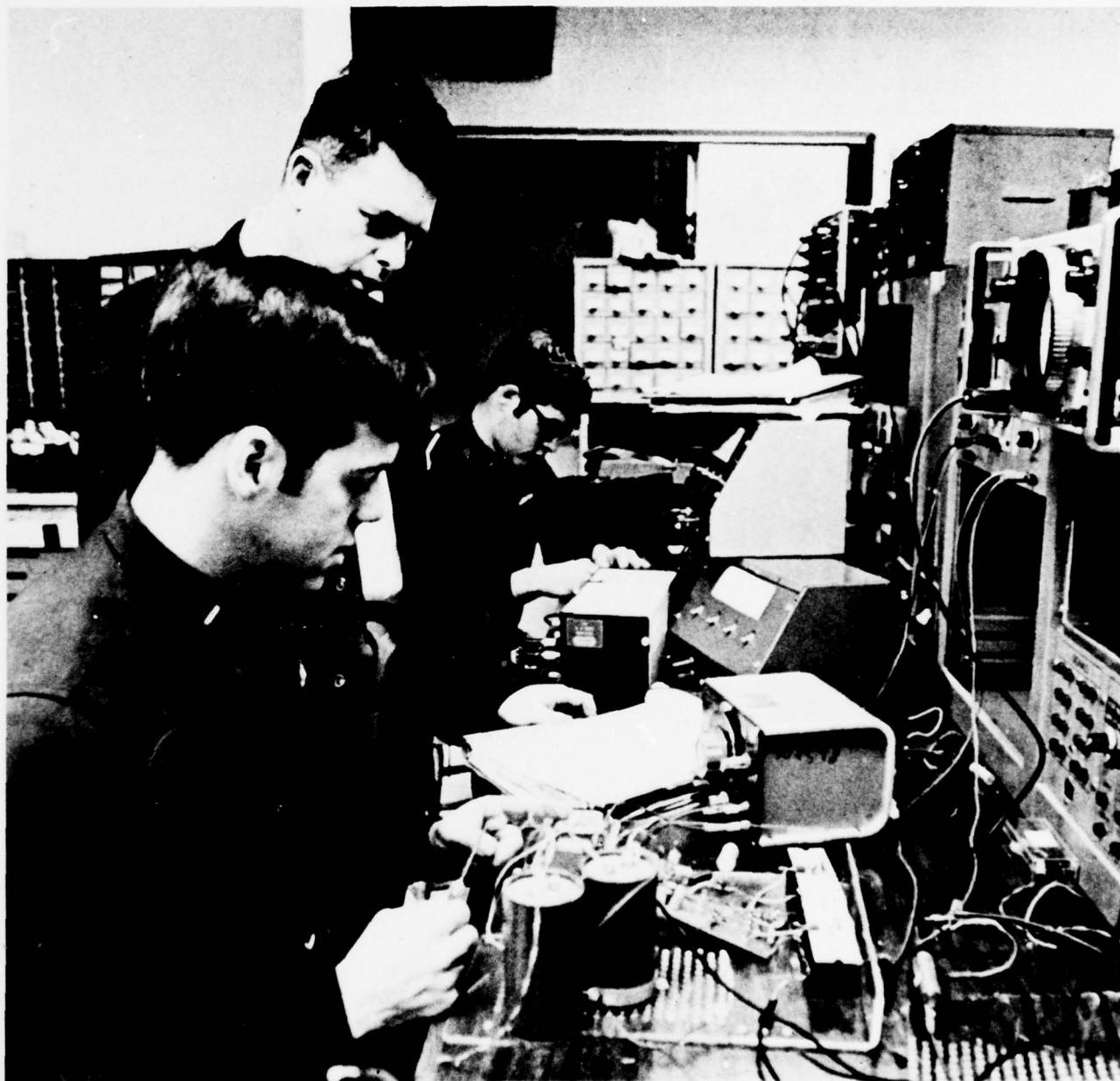
This is a joint research project between Children's Hospital, National Medical Center, Washington, D. C. and the U. S. Naval Academy.

The objective is to develop a safe, noninvasive method of assessing the severity of congenital aortic stenosis in children by utilizing computer analysis of phonocardiograms.

The phonocardiogram data are recorded on magnetic tapes during cardiac catheterization at Children's Hospital and analyzed on the USNA TSS computer system. The first spectral movement ( $\bar{S}$ ) of the averaged power spectrum of a quasi-stationary segment of the aortic

murmur is correlated with the peak systolic pressure gradient and the aortic valve area. The research will be meaningful if significant correlation between  $\bar{S}$  and the aortic valve gradient can be established, thus providing an estimation of the gradient in patients with aortic stenosis, without the need for cardiac catheterization.

Currently data acquisition and computer program development for data conversion and analysis are in progress.



## THE ABSORPTION OF SOUND BY PINE TREES

Researcher: Associate Professor Stephen H. Burns

During this past year, it has been attempted to measure the absorption of sound by pine boughs from 200 to 6 kHz. These measurements were undertaken by exposing the boughs to a reverberant sound field in a .546 m X .848m X .794m box constructed of 3/4 inch plywood with a 5 cm thick reinforced concrete lid. The box was set in the ground to within 5 cm of its rim, and the gap between the box and the excavation was tamped full of gravel. Both the box and the lid were sealed with varnish. The gasket consisted of foam-rubber-bead weatherstripping tacked on top of the box and compressed by the lid to provide an airtight seal. These precautions were taken in order that the walls of the box would be as lossless as possible.

Sound was introduced by a small tube into one corner of the box and was transduced by a ceramic microphone set flush with the wall near the opposite corner. In addition, the motions of the boughs were transduced near the bottom of the box where they were clamped. An experimental run consisted of eight sweeps of the frequency from 200 to 6 kHz and successive recording of: the microphone with the box empty, the microphone with the boughs present, the X and Y motions of each of the two boughs, the microphone with the boughs present, and the microphone with the box empty. Because of the high Q of the box, each sweep required about 40 minutes. Also, it was necessary to measure the geometrical properties of each bough.

Ten pairs of pine boughs were tested in this manner. These and several other tests make it appear unlikely that the absorption mechanism involves a mechanical resonance of either the needles or the boughs, as has been suggested by another investigator. Presumably the only remaining mechanism is thermoviscous absorption in the boundary layer of air near the needles. This possibility must next be examined theoretically as this investigation continues.

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## ON THE REALIZATION OF VOLTAGE TRANSFER FUNCTIONS BY DISTRIBUTED ACTIVE NETWORKS

Researcher: Associate Professor Charles A. Fowler III

Distributed RC-networks and an operational amplifier have been used to realize low-pass quadratic open-circuit voltage transfer functions. The synthesis procedure matches the coefficients of the network transfer function with the coefficients of the transfer function to be realized. The parameters of the cut-functions of the distributed network are determined from the resulting set of algebraic equations.

To adapt the method to higher order transfer functions, it is shown that a matrix that characterizes the network can be put in a form where its elements are dependent only on the order of the transfer function to be realized. An algorithm is presented which will generate the elements of the characteristic matrix to be used in the synthesis procedure of a transfer function of any order.

The characteristic matrix must be inverted in order to determine the coefficients that define the contours of the distributed network. It is shown that the adjoint of the characteristic matrix and the determinant of the characteristic matrix can be evaluated by means of two new simple algorithms. Computer programs based on these algorithms have been written. The characteristic matrices and their adjoints for transfer network must be tested to see if they remain on the network. The general form of the equation to be used is given.

Criteria are developed which can be used by the network designer to tell him, prior to beginning the synthesis procedure, whether or not a given transfer function of first- or second-order can be realized. A new method of determining realizability, called the Uspensky-Descartes scheme, is developed and applied to third-order transfer functions.

A design method of interest to one using optimization techniques is presented. Using this method, one can determine the coefficients of a transfer function of any order that is realizable by a distributed network in conjunction with an operational amplifier.

Typical design results showing the contours and tabulations of the coefficients of the contour functions have been obtained and are presented.

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#### FORMULAS FOR A CLASS OF OPTIMAL LADDER-NETWORKS

Researcher: Assistant Professor Tian S. Lim

This research project is concerned with a special class of optimal ladder-networks. The outcome provides an insight into some very useful properties of the tridiagonal matrix  $[A]$  of the state equation  $[V] = [A][V] + [B]u$ , which describes a certain type of double-terminated ladder-networks. It has been found that the  $[A]$  matrix of the optimal ladder is antimetrical and the sum of the diagonal elements is equal to the sum of the eigenvalues of  $[A]$ . If, in particular, the eigenvalues  $p_i$  are distributed in such a way that  $p_i = ip_1$ , then the diagonal elements of  $[A]$  are equal and each is equal to the sum of eigenvalues of  $[A]$  divided by the number of eigenvalues. Several proofs of formulas have been formulated, but more are yet to be found.

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## A MUSICAL-TONE GENERATOR PROVIDING AN EVEN-TEMPERED SCALE

Researcher: Midshipman 1/C Stefan Fedyschyn

Adviser: Associate Professor Herbert M. Neustadt

This project was primarily devoted to testing a recently developed analog method for generating an even-tempered musical scale. Even-tempered scales are, of course, used in pianos, organs, and other keyboard musical instruments. The defining property of such a scale is that two notes, a semitone apart in the scale (C and C sharp, for example), have a frequency ratio equal to the twelfth root of two.

The conventional method nowadays for generating such a scale is to use a set of digital frequency dividers. To show how this method works, suppose that the note C is generated by dividing a master clock frequency by the integer 478. Then, if this same clock frequency is divided by the integer 451, the resultant frequency differs by not more than four parts in ten thousand from the frequency required for an even-tempered C sharp. Thus by the use of digital frequency dividers, the even-tempered frequencies can be approximated with adequate precision.

A more recently developed method of generating musical frequencies uses analog devices instead of digital dividers. The main elements of the analog system are a voltage-controlled oscillator and a matched-transistor pair in which the output current is, with small error, an exponential function of the input voltage. The analog system is substantially simpler and less expensive than the set of frequency dividers required for the digital system. The question that naturally arises is: How does the accuracy of the analog system compare with that of the digital system? It was this question that Midshipman Fedyschen answered by constructing and testing a working model of the analog system.

The answer that comes from Midshipman Fedyschen's measurements is that a typical frequency error for the analog system is 1%, or one hundred parts in ten thousand. With this large an error, the analog system should be provided with an auxiliary timing system so that each individual note can be fine-tuned to minimize frequency error. The requirement for these individual tunings is a disadvantage of the analog system in comparison with the digital dividers. However, the simplicity and low cost of the analog system make it competitive with the digital system even when the individual tunings are included.

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A COMMUNICATION INTERFACE BETWEEN THE KIM-1 MICROCOMPUTER AND THE USNA TSS COMPUTER SYSTEM

Research: Midshipman 1/C Benjamin Richter

Adviser: Associate Professor Antal A. Sarkady

Two serial digital data ports have been developed for the KIM-1 microcomputer. The maximum data-transfer rate through port one is software selectable in the range of 110-9600 baud and meets the RS232 standards. The maximum data rate of port two is fixed at 300 baud and meets the 20mA current loop requirements. Data transfer between the ports and the KIM-1 microcomputer is controlled by a vectored hardware priority interrupt logic circuit.

The data ports will connect the KIM-1 microcomputer to a system console teletype and to the USNA TSS computer system.

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FABRICATION OF A PROGRAMMABLE READ MOSTLY MEMORY USING BISTABLE AMORPHOUS BISMUTH TRIOXIDE THIN FILM DEVICES

Researcher: Midshipman 2/C Robert S. Weis

Adviser: Assistant Professor Jake H. Halford

Amorphous semiconductor devices have two major advantages over crystalline semiconductors. First, they are easier to fabricate and second, they possess true memory non-volatility. This project involves the study of bistable  $\text{Bi}_2\text{O}_3$  conducting amorphous thin film devices and their application in the diode matrix of a thin film. Since amorphous devices can easily be electrically switched from OFF to ON, this allows the conversion of a Read Only Memory (ROM) to a Programmable Read Only Memory (PROM). If the amorphous devices can be readily turned ON and OFF, the result will be a non-volatile thin film, Programmable Read Mostly Memory.

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FOWLER, Charles A. III, Associate Professor, and Wesley K. KAY, Associate Professor, Rotating Machines and Magnetic Devices, (Used as a text in EE312).

The main topics covered in this text are magnetic fields and effects, transformers, basic synchro and servo systems, principles of electro-mechanics, d-c generators and motors, three-phase systems, a-c generators and motors. The principles of operation of these devices are discussed, as well as some of the main operating features such as rating, losses, operating characteristics, performance under varying load, starting, and control of output.

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MARTIN, Richard L., Associate Professor, co-author, "Effects of Total Dose Ionizing Radiation on the 1802 Microprocessor," IEEE Transactions on Nuclear Science, NS-24 (December 1977), 2172-2176.

The RCA CMOS microprocessor, the CDP1802, is of interest for many military and space system requirements, because of the several inherent advantages of the CMOS technology over other MOS technologies: low power, high noise immunity, operation over a wide temperature range, and the possibility of implementing previously developed radiation hardening processing techniques.

Previous testing at Naval Research Laboratory on the 1801 two-chip version of this microprocessor indicated that catastrophic failure occurred for this Si-gate CMOS technology at radiation levels between 1 and  $3 \times 10^4$  rads (Si) for a 5-volt power supply and typical devices. A marginal unit with high initial leakage current failed between 1 and  $2 \times 10^3$  rads (Si).

This report discusses subsequent radiation testing of off-the-shelf as well as specially processed radiation hardened 1802 microprocessors using low temperature techniques. The failure levels for the standard units are consistent with the previously reported 1801 results. The specially processed units are between 1 and 2 orders of magnitude more tolerant to ionizing radiation. That is, for a 5-volt irradiation bias the failure level was greater than  $1 \times 10^5$  rads(Si).

Tests were performed both with a bench top set-up, in which the RCA Microkit was utilized, as well as with an automated integrated circuit test system.

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MARTIN, Richard L., Associate Professor, "Effects of Ionizing Radiation on the CDP1802 Microprocessors," IEEE Annual Conference on Nuclear and Space Radiation Effects, College of William and Mary, Williamsburg, Virginia, 12-15 July 1977.



## MECHANICAL ENGINEERING DEPARTMENT

*Professor Vincent J. Lopardo, Chairman*

Faculty and midshipmen research in the Mechanical Engineering Department covers many of the areas of specialization in mechanical engineering. These include research in direct energy conversion, fluid mechanics, heat transfer, acoustics, dynamic effects, stress corrosion cracking, fracture mechanics, welding technology, design, and computer-aided graphics.

Research is supported through funds from eight different government agencies with the David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory, providing opportunities for several faculty members to work on projects during the intersessional period. Additionally, some faculty members have undertaken independent research in their areas of expertise. Including all levels of research, 15 civilian and two military faculty members have been active in the research of the Department this year.

An important part of the Department's research effort during the year has been the involvement of midshipmen in independent research, design, and development projects. Current midshipmen interests include the Naval Academy Heat Balanced Engine, and many aspects of fluid mechanics.

Supporting the research effort in mechanical engineering are the sophisticated laboratory facilities located in the Rickover Hall complex. The Department maintains facilities for performing experimental research in several areas: fluid mechanics, solid mechanics, materials science, experimental-stress analysis, control systems, mechanical vibrations, heat transfer, and thermodynamics.

The primary driving force behind the Department's research is the real need for the faculty to stay abreast of technological developments in the many diversified areas of mechanical engineering in order to be more effective classroom teachers.

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HEAT TRANSFER ANALYSIS OF THE NAHBE PISTON CAP

Researcher: Professor James A. Adams

Sponsor: Office of Naval Research (Code 483) and Naval Material Command (Code 03Z)

The cap on the piston-head of a NAHBE engine undergoes a complex thermal response during engine operation. A heat-transfer analysis which modeled the cap as a fin with transient conduction and variable surface heat-transfer coefficients was made. Computer solutions were obtained by using an explicit, finite difference technique. Parametric studies were made for different engine speeds between 500 and 5,000 RPM, and for different fin-thickness. Conclusions showed that:

(1) The actual measured performance could be reasonably approximated by a proper choice of parameters.

(2) Replacing an aluminum cap with a steel cap increased the operating temperature by 25%.

(3) Increasing the thickness of an aluminum cap reduced its maximum temperature by 10%.

(4) The regenerative effect due to the cap is not as great as had been expected.

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PYRAMIDAL INDENTATION OF TWO-PHASE MATERIALS

Researcher: Professor Thomas W. Butler

Sponsor: Naval Academy Research Council

The objective of the current work is to determine force-indentation relationships for indentation by pyramidal indenters of two-phase materials and to apply the relationships to composite materials.

A theoretical investigation was made of the forces required to indent a type of ductile layered two-phase material by a rigid smooth rectangular-based pyramid. The semi-infinite material considered has a central rigid-perfectly plastic phase and contiguous regions on either side of the central phase, which have a yield strength either higher or lower than the central phase. Using the upper-bound plasticity-limit theorem and kinematically admissible velocity fields, upper-bound indentation forces are found for the entire range of indentation sizes. The model of deformation which was chosen for the purposes of upper-bound calculations was to be based on physical observations of how the metal deforms.

Force-deflection relationships have been found for pyramidal indentations of materials with the geometry outlined above by extending the earlier wedge-indentation results. These results have been applied to experimental results in W-Ni-Fe alloys, with the result that valid matrix-hardness values as a function of W-content have been obtained.

An interesting sidelight to the results obtained is the experimental observation that for sufficiently small microhardness-loads (less than about 50 g) there is no material build-up outside of the pyramidal indentation. A pushed-out region which was expected by elementary volume-conserving plasticity-theory was not found.

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#### MECHANICAL TRANSMISSIONS FOR HIGH PERFORMANCE SHIPS

Researcher: Associate Professor Elliott E. Dodson

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

This task consisted of the editing of a final report of a Workshop on Mechanical Transmissions for High Performance Ships. The workshop which was subdivided into four working groups, brought together experts from both government and industry. The working groups dealt with overview, state-of-the-art, operational problems, research and development, and specifications and procurements. The need for a workshop stemmed from the Navy's interest in high-performance craft, which has created a requirement for marine transmissions with new constraints. The components of these transmissions must be lightweight and, therefore, high loaded. Additionally, they must operate within a flexible structure and cope with the adverse marine environment. This transmission system is different from former transmissions of aircraft or marine type. Operational problems have resulted, and still further problems are anticipated in moving to higher power and larger craft.

The goals of the workshop were: (1) To define the state-of-the-art of mechanical transmissions; (2) to determine what development is suggested by the needs of current and future Navy craft; (3) to determine what supporting research is required to aid this development; (4) to establish the development which is required to solve current problems with gearing-related transmission-components and transmission systems; and (5) to provide guidelines for Navy procurements, specifications, and development of mechanical transmission systems.

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NAHBE PARAMETRIC TESTING

Researcher: Lieutenant Commander Charles C. Failla, USNR

Sponsor: Office of Naval Research (Code 483) and Naval Material Command (Code 03Z)

This project involved performing a parametric-testing program of the Naval Academy Heat Balanced Engine (NAHBE), a test series that will require approximately 400 hours of run time. The data obtained from this test along with that of planned tests will be used to build a computer model of the NAHBE engine.

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COMPUTER ANALYSIS AND DISPLAY OF FATIGUE DATA

Researcher: Lieutenant Jerry M. Fine, USN

Sponsor: David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory

Computer software was developed for use with the Tektronix-4051 minicomputer for analyzing cyclic crack growth and flexural fatigue data. Programs were designed to: (1) Calculate crack-growth rates versus stress-intensity factors from raw fatigue; (2) analyze and display low-cycle fatigue data with confidence limits; and (3) analyze and display high-cycle fatigue data with confidence limits.

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INTERACTIVE COMPUTER GRAPHICS TECHNIQUES FOR USE IN FINITE-ELEMENT PROBLEMS

Researcher: Lieutenant Jerry M. Fine, USN

Sponsor: Naval Academy Research Council

Both the GIFTS (Graphics-oriented Interactive Finite Element Time-sharing System) and the TOTAL system, which have been developed under the auspices of the Office of Naval Research, provide for the solution of stress-and-displacement fields in solid bodies with accompanying computer-graphics displays. This research will attempt to modify certain features of these program-packages to obtain routines useful in the solution of fluid mechanics problems, particularly two-dimensional boundary-layer flow, using the finite-element method. The emphasis will be on automatic and semi-automatic mesh generation, display, and modification.

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COST-BENEFIT STUDY OF MARINE SANITARY DEVICES

Researcher: Associate Professor John O. Geremia

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

A cost study was made of two systems for shipboard use: CHT's (Collection, Holding and Transfer systems) and MDS's (Marine Sanitary Devices). The first is passive insofar as no treatment is carried out on the ship. MSD's treat the waste before disposal. Available cost figures are very limited. Calculations must be based on figures adjusted by the rate of inflation. The figures indicate CHT's would be less costly over their lifetime. MSD's are desirable for political reasons. Engineering development of MSD's is moving at a fast pace, and their continued use is recommended. A Navy-wide system of gathering cost-information is recommended for more accurate cost-benefit analysis.

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INVESTIGATION OF SEEDING EFFECTS ON CONDENSATION

Researcher: Research Professor Joseph D. Gillerlain, Jr.

Sponsor: Naval Air Systems Command

This project centers on the investigation of the effects of seeding on the condensation of water vapor in aerodynamic nozzles. The experiments are aimed at gaining further knowledge of the fundamental processes involved in heterogeneous nucleation, i.e., phase-transition based on existing nuclei of different species, with respect to initial particle-formation and subsequent growth rates. The results have important applications in such areas as hurricane seeding-techniques and anti-fog devices for airports.

The USNA Aerodynamics Laboratory chemical-kinetics wind-tunnel will be utilized. The condensation nuclei will be provided by chemical salts generated in the atmospheric inlet of the wind tunnel. Collected samples of these particles will be examined for size distributions using a scanning electron-microscope. Pressure distributions will be obtained by axial traverse of the wind-tunnel test-section. It is planned that a laser velocimeter will be utilized to obtain velocity profiles at different axial positions in the flow for comparisons with results calculated from the equation of fluid motion.

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## INVESTIGATION OF VORTEX-CONTROL FIN INTERACTIONS

Researcher: Assistant Professor Joseph D. Gillerlain, Jr.

Sponsor: Naval Surface Weapons Center, White Oak Laboratory

The objective of this investigation is to develop predictive methods for the aerodynamic behavior of missiles and aircraft experiencing vortex-impingement on control surfaces. Accurate prediction of such phenomena becomes essential as maneuvering requirements become more severe, requiring flying at larger angles-of-attack. Detailed knowledge of the three-dimensional viscous-flow field, as determined from wind tunnel experiments, is required in order to model the vortex-fin interaction and to develop predictive methods. Comparisons with existing potential methods will be made.

The experimental measurements will be made in the U. S. Naval Academy Aerodynamics Laboratory subsonic Aerolab wind tunnel. A pressure-distribution model, consisting of a rectangular fin with a cylindrical leading-edge, will be built. Non-intrusive flow-measurement and flow-visualization techniques will be used, to include laser anemometry and the fluorescent mini-tuft method, respectively. A three-dimensional laser-Doppler-velocimeter (LDV) will be used to survey the vortex-fin interaction flow field. The pressure distribution data will be integrated to obtain aerodynamic forces, which will be compared with force balance data. Conventional methods of wing/fin analysis will be used to predict the aerodynamic loads on the fin induced by the vortex. These analytical results will be compared to the actual measured loads determined from force-balance and pressure-distribution data. The various predictive methods will be compared.

The program was initiated during the third quarter of FY 1978. During the third and fourth quarters of FY 1978, existing theories will be studied and evaluated. Also, the design and fabrication of a pressure-distribution model will be completed. Some preliminary flow visualization tests may be conducted to develop expertise in the fluorescent mini-tuft technique, while at the same time varying fin geometry.

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## EVALUATION OF MECHANICAL PROPERTIES AND FRACTURE BEHAVIOR OF 4-INCH THICK TITANIUM WELDMENTS

Researcher: Assistant Professor Dennis F. Hasson

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The objective of the study was to evaluate the effect of heat-input and out-of-position welding on the mechanical and stress-corrosion-cracking (SCC) behavior of satisfactory welds. All welds are to be produced by gas-metal-arc pulsed welding of 4-inch-thick titanium plate. In addition a special weld configuration was utilized to produce specimens for specific evaluation of the heat-affected-zone. Major and interstitial chemical element analyses, metallography, dynamic tear-tests, wedge-opening-load, SCC tests and fractography will be performed on the weldments. All weldments have been produced and a large part of the mechanical tests have been performed. Fractography and SCC tests are planned for the near future. A report on the effect of heat input on the mechanical properties of 4-inch welds is in preparation. At least two additional reports, one on the heat-affected-zone study and the other on out-of-position welding, will also be prepared.

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## STRESS-CORROSION-CRACKING BEHAVIOR OF ARMOR-PIERCING METALLIC-ALLOYS

Researchers: Assistant Professors Dennis F. Hasson and James A. Joyce

Sponsor: Naval Surface Weapons Center, White Oak Laboratory

Information leading to an understanding of the stress-corrosion-cracking (SCC) behavior of DU alloys is required to support the design of an advanced system. SCC tests which utilize a cantilever-beam apparatus are performed in moist saltwater air. The crack-growth-rate is recorded, and, from the appropriate fracture mechanics analysis, the critical stress intensity for SCC,  $K_{ISCC}$  as well as crack growth rate is determined for each alloy. Supporting metallographic, chemical and fractographic analyses will be performed off site.

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COMPARATIVE ANALYSIS OF THE PROBABILITY OF DETECTION OF BUOY SIGNAL-LIGHTS

Researcher: Associate Professor Richard A. Hirsch

Sponsor: United States Coast Guard

Because of the action of waves, buoys execute tilting motion which can prevent the sighting of the navigation light. The U. S. Coast Guard has collected data on these angular motions for various buoy designs and at various times of the year. This research is concerned with calculating the probability of an observer detecting the light given the tilting motion of the buoy and the divergence angle of the lens. A model was developed and probabilities calculated for six buoys, four divergence angles and three deployments (summer, winter, spring). A report is in preparation.

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FATIGUE-MACHINE CONTROLLER DEVELOPMENT

Researcher: Assistant Professor James A. Joyce

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The objective of this project is to assemble a fatigue-machine controller for the David W. Taylor Naval Ship Research and Development Center (DWTNSRDC) identical to that which presently exists in Rickover Hall at the U. S. Naval Academy. This instrument produces precisely-cracked specimens for fracture-mechanics research. The unit is a result of design and development efforts by Assistant Professor Joyce and H. Lee of the CADIG group. Electronic components are now being assembled. This control unit was completed, tested, and installed at DTNSRDC. Tables of controller-valves have recently been produced for several types of test-specimens commonly used at DTNSRDC, and these are being assembled in a report.

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SINGLE SPECIMEN  $J_{IC}$  TEST PROCEDURE DEVELOPMENT

Researcher: Assistant Professor James A. Joyce

Sponsor: National Science Foundation

The objective was to develop a viable single specimen  $J_{IC}$  test procedure and to develop using this procedure data on the specimen size requirements for valid  $J_{IC}$  testing; both objectives were met and this work was completed during October 1977. A final report has been submitted to the sponsor.

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SPECIMEN GEOMETRY INVESTIGATION FOR  $J_{IC}$  TESTING

Researcher: Assistant Professor James A. Joyce

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory, and Nuclear Regulatory Commission

The objective of this investigation is to continue the work sponsored by the National Science Foundation to determine the optimum specimen geometry for  $J_{IC}$  and  $J_I$ -R curve testing. The results of these investigations are expected to direct the testing of irradiated nuclear-pressure vessel-specimens, now being stored at Oak Ridge Laboratory. These specimens are critical to determining the safety of several nuclear power-plants now in commercial operation in this country. A paper was presented at the 11th National Conference on Fracture (ASTM) in June 1978 in Blacksburg, Virginia.

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## THREE-POINT-LOADING BEAM-COMPLIANCE FOR CRACK-LENGTH ESTIMATION

Researcher: Assistant Professor James A. Joyce

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The objective of this project is to develop a Tektronix-4051 BASIC program to measure the crack-length of a fatigue-precrack in a stress-corrosion-cracking bend bar. Once an accurate crack-length is measured, subsequent load-levels for further testing can be accurately determined.

Analytical and experimental results will be combined to give a compliance equation which gives accurate results for the simple test geometry being used.

A BASIC program has been written using the compliance expression of Paris and Tada's Handbook. When experimental results are completed, this expression will be adjusted to accurately fit the observed results.

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AN INVESTIGATION OF THE BEARING FORCES ACTING ON THE NON-POWERED PERISCOPE FOR SSBN

Researcher: Associate Professor William M. Lee

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The persistent problem of high-torque required when maintaining target training was investigated. Two methods of analysis were employed for determining the bearing loads. Close agreement in the results was obtained.

As a result of the investigation, a short-term solution was proposed, that being the removal of one of the four bearings. A long-range solution was proposed which involved redesigning the bearing mounts to provide more flexibility of the periscope when in use, thus lowering torque required for target training.

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THE EFFECTS OF DRAG-REDUCING POLYMERS ON THE TURBULENCE CHARACTERISTICS OF THE HYDRAULIC JUMP

Researcher: Assistant Professor Thomas H. Reif

Sponsor: Naval Academy Research Council

The time-averaged velocity and Reynold's stress-distribution in the classical hydraulic jump have been investigated by the researcher, using a laser-Doppler anemometer. This investigation found the laser ideally suited for these measurements, since it was both non-interfering as well as relatively impervious to small amounts of entrapped air in the flow. The present study utilized these techniques in measuring the effects of the known drag-reducing-polymer, polyacrylamide (Calgon TRO-375), on the flow field. The results of these measurements indicate that the mean-flow and turbulence-characteristics are dependent on the concentration of the drag-reducing agent.

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THE VIBRATIONAL RESPONSE OF PIPES EXCITED BY THE FLOW OF HIGH-PRESSURE AIR

Researcher: Professor John P. Uldrick

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The objective of this investigation was to develop quiet piping-design criteria for inclusion in the design specifications applicable to new ship-design. Measurement and 1/3-octave structureborne acceleration analysis of bare straight pipe conveying high pressure air has been carried out at David W. Taylor Naval Ship Research and Development Center. The mechanisms of flow-noise generation as well as the structural dynamics of the pipe have been studied.

Numerical analysis of the experimental data reveals that the structure-borne noise depends upon a power of the flow-velocity in the range between four and eight. Furthermore, the acoustic coupling between the fluid and pipes as described by the joint acceptance function, modal-damping ratio, and modal frequencies is indicated. It is shown that the coupling factor as well as the power on velocity is dependent upon the 1/3-octave band under consideration. Additionally, the noise-level-prediction formulation is extended to cover the total structureborne acceleration levels in 1/3-octave bands 30 through 39.

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EXPERIMENTAL INVESTIGATION OF SHIPBOARD FACILITIES-MAINTENANCE AND  
MANPOWER-UTILIZATION

Researcher: Associate Professor Chih Wu

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The purpose of this research was to conduct experimental investigations of methods for reducing shipboard-maintenance manpower requirements while improving the cleanliness and appearance of ships. New concepts in labor-saving equipment, management techniques, manpower organization, and training will be tested aboard operational ships.

During this period, the researcher developed and documented the fundamental experimental design concept for the investigation in a report which lays the groundwork for the conduct of the investigation.

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CROSSFLOW OVER A POROUS CIRCULAR-CYLINDER WITH UNIFORM FLOWING AT THE SURFACE: A STUDY AT HIGH BLOWING-RATES

Researcher: Assistant Professor Thomas H. Reif

Crossflow over a porous circular-cylinder, with uniform blowing at the surface, has been investigated experimentally and analytically for high-blowing rates. Experiments were conducted at two different free-stream conditions,  $Re = 4100$  and  $6200$ , and three different wall-blowing rates, corresponding to  $u_w/U_\infty = 0.190, 0.154, 0.126,$  and  $0.102,$  and  $0.0$ . Time-averaged velocity profiles were obtained over the entire circumference of the cylinder. Flow-visualization techniques were used to obtain qualitative information concerning the total drag and separation angle. The analytical study employed the Galerkin method to obtain an approximate solution for the flow-field around the entire circumference of the cylinder. The theory was found to give good agreement with the experiments close to the surface of the cylinder for high blowing rates. Results for the theoretical drag-coefficient and separation-angle were also obtained. Increased blowing was shown to increase the total drag and to decrease the separation-angle.



DEVELOPMENT OF A LABORATORY APPARATUS TO DEMONSTRATE THE HYDRODYNAMIC THEORY OF LUBRICATION

Researcher: Midshipman 1/C Louis R. Cirelli

Adviser: Assistant Professor Thomas H. Reif

A theoretical study was conducted using the results of Boyd and Raimondi (1958) to design a test apparatus to demonstrate the hydrodynamic theory of lubrication. The diameter of the journal was based on the physical restraints of pressure measurement. The clearance was set according to the optimization of the minimum film thickness and wear considerations. Design curves were generated for maximum load, volume flow rate of lubricant, and maximum pressure as a function of journal speed. Technical drawings were completed from which the apparatus can be built.

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S. I. COMPUTER PROGRAMS FOR USE IN THERMODYNAMICS

Researcher: Midshipman 1/C John Cooke

Adviser: Assistant Professor Eugene L. Keating

Two computer programs written in BASIC have been developed, tested, and transferred to the Mechanical Engineering Department Computer Library for use in the thermal/fluids discipline.

"CNSTAB" is a BASIC subroutine capable of calculating the thermodynamic properties of steam through algorithms and tabulated data. The values are based on the Keenan and Keyes steam tables. "CNSTAB" utilizes the basic subroutine "STMTAB" in which the actual values are calculated. "CNSTAB" itself provides the added capability of input and/or output in English Engineering or Systems International (SI) units.

"Rankine" is a BASIC program which can provide a teaching aid for an introduction to the simple Rankine Steam Cycle. It provides equipment orientation via a block diagram, familiarizes the student with the h-s and T-s diagrams, and computes the normally required data that is received from a Rankine Cycle analysis.

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LIQUID & GASEOUS FUEL-FIRED BURNER CHARACTERISTICS

Researchers: Midshipmen 1/C Kevin M. Hannan and David E. Nix

Adviser: Assistant Professor Eugene L. Keating

The experimental characteristics of a liquid/gaseous fuel-fired burner are to be investigated. A continuous combustion unit located in Rickover Hall was used for this study, which allows experimental measurement of fuel type, fuel-flow rate, air/fuel ration, coolant-flow rate, igniter-energy input, flame temperature, and products of combustion. Observed flame characteristics, i.e., temperature, color, heat transfer characteristics, and structure as a function of the above-mentioned variables were made. Comparisons will be made to theoretical predications using basic thermochemistry. The results of this study will demonstrate, document, and dedicate these facilities for further use in the Mechanical Engineering curriculum next year.

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ORSAT EXHAUST-GAS ANALYSIS-FACILITY DEVELOPMENT

Researcher: Midshipman 1/C Paul Lynch

Adviser: Assistant Professor Eugene L. Keating

An Orsat exhaust-gas analysis-facility was developed for use in the thermal/fluids discipline of the Mechanical Engineering Department. The facility, located in Rickover Hall, will allow direct measurement of CO, CO<sub>2</sub>, N<sub>2</sub>, excess O<sub>2</sub>, and unburned hydrocarbons. Development of the facility will include the creation of operating instructions, sample calculations, and the application of the unit to several combustion systems. Usage of the Orsat equipment will allow instructional studies of such systems as the steam boiler, gas-turbine exhaust, and diesel-engine exhaust.

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FLOW CHARACTERISTICS OF SAILS

Researchers: Midshipmen 1/C William D. McCain and Henry L. Pruitt

Adviser: Assistant Professor Thomas H. Reif

The effects of the addition of masts to sail-like, two-dimensional airfoil sections was studied by Milgram (1978) by water tests. The present investigation attempted to reproduce these experiments on a larger model with wind-tunnel tests. A geometrically similar airfoil was designed, built, and installed in a low-speed wind tunnel at the U. S. Naval Academy. The airfoil section was instrumented for pressure

measurements over the upper and lower surfaces as well as of the entire circumference of the mast at the leading edge of the model. A flow visualization apparatus was set up using a helium-bubble generator. Only preliminary measurements have been made at this time and the results are still being processed.

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#### A LASER-DOPPLER ANEMOMETER STUDY OF THE CLASSICAL HYDRAULIC JUMP

Researcher: Midshipman 1/C Aris P. Metrakos

Adviser: Assistant Professor Thomas H. Reif

Researchers have been fascinated by the hydraulic jump for centuries. However, measuring problems encountered in this two-phase flow have prevented accurate estimates of time-averaged velocity-distribution and Reynold's stresses. This investigation found the laser-Doppler anemometer ideally suited for these measurements, since it was both non-interfering as well as relatively impervious to small amounts of entrapped air in the flow. The results of this study indicate a more distinct curvature in the velocity-profile and a considerably greater turbulence level than what was previously measured by Rouse (1959) in an air-model of the hydraulic jump. These discrepancies were attributed to the presence of the unstable free surface and the higher Reynold's numbers encountered in the actual hydraulic jump.

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#### A PRELIMINARY STUDY OF THE AERO AND HYDRODYNAMICS OF A TUNNEL-BOAT-HULL

Researcher: Midshipman 1/C Jorge B. Ortega

Adviser: Assistant Professor Thomas H. Reif

Preliminary fluid-flow measurements were conducted on a scale model of a Molinari tunnel boat hull. These measurements consisted of a wind-tunnel study of the aerodynamic characteristics and a tow-tank study of the hydrodynamic characteristics of the hull-form. The results of the aerodynamic study include total drag measurements, pressure distributions on the upper and lower decks, and some flow visualization. The hydrodynamic study resulted in a plot of the residual drag coefficient as a function of Froude-number and trim-angle. The results of the two studies were compared and the aerodynamic drag force was estimated to be approximately 11% of the hydrodynamic drag force on the full scale hull for a boat speed of 100 mph (160.9 km/s) at a trim angle of 3.0.

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ADAMS, J. Alan, Professor, "Heat Transfer Analysis of the NAHBE Piston Cap," USNA Report EW-11-77, September 1977.

The cap on the piston-head of a NAHBE engine undergoes a complex thermal response during engine operation. A heat-transfer analysis which modeled the cap as a fin with transient conduction and variable-surface heat-transfer coefficients was made. Computer solutions were obtained by using an explicit, finite-difference technique. Parametric studies were made for different engine speeds between 500 and 5,000 RPM, and for different fin thickness. Conclusions showed that: (1) the actual measured performance could be reasonably approximated by a proper choice of parameters; (2) replacing an aluminum cap with a steel cap increased the operating temperature by 25%; (3) increasing the thickness of an aluminum cap reduced its maximum temperature by 10%; and (4) the regenerative effect due to the cap is not as great as had been expected.

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BUTLER, Thomas W., Professor, "Analysis of Coanda/Refraction Noise Suppressor Design Parameters for Naval Jet Engines," USNA Report EW-9-77, September 1977.

Based upon results of successful tests on one type of jet engine (J57-P21) in the afterburning mode of operation in a Coanda/refraction noise suppressor, a dimensional analysis has been performed which indicates how to select dimensions for Coanda/refraction surfaces for other types of jet engines. Surprisingly, a fairly large number of engines appear to be suitable for use in the same noise suppressor used for J57-P21 AB. Dimensions are given for other engines and a critical test is suggested.

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GEREMIA, John O., Associate Professor, "Test Less, Learn More," Machine Design, (8 September 1977), 110-115.

The process of optimization is described through an example on the optimization of a new engine design. The problem involves three independent and two dependent variables. Both dependent variables are to be optimized simultaneously, if possible.

The approach taken is to visualize the three independent variables as forming the axes of a test space. All points on and within the test space are possible combinations which can be run in an experiment. Selecting a sample of points from the space is exceedingly important.

A selection scheme is described, and it is shown how the results of the experiment may be manipulated to form empirical equations which describe both main and interaction effects.

Once an equation for each independent variable is obtained, optimization may proceed with contour plots of the results.

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HASSON, Dennis F., Assistant Professor, co-author, "Effect of Heat Input on the Mechanical Properties of GMAW Pulsed-Current Ti-6Al-2Cb-1Ta-0.8Mo Weldments," DWTNSRDC Report MAT-77-34, August 1977.

Two-inch-thick Ti-6Al-2Cb-1Ta-0.8Mo titanium-alloy weldments were fabricated to determine the effects of heat input on certain mechanical properties. Comparisons were made between a weldment produced with a multiple-heat-input technique and three weldments, each fabricated at a different single-heat input. No major differences in weld chemistry, tensile-strength properties, fracture toughness, or mode of fracture that could be related to heat input were observed. However, tensile yield strength decreased with increasing heat input, and tensile ductility was significantly lower in the highest-heat-input weldment. The practice of using that heat input which will result in weld-bead-deposition characteristics most suitable for the pass location in the joint is acceptable for titanium multipass welding.

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HASSON, Dennis F., Assistant Professor, co-author, "Explosion-Tear Test Performance of 2-Inch-Thick Ti-6Al-2Cb-1Ta-0.8Mo Alpha-Beta Processed Plate and Weldments," DWTNSRDC Report MAT-77-33, September 1977.

Two-inch-thick alpha-beta rolled Ti-6Al-2Cb-1Ta-0.8Mo titanium-alloy plate, and weldments produced by the gas metal-arc welding pulsed-current process and the gas metal-arc welding spray process were evaluated. Comparisons were made with weldments made by the gas tungsten-arc welding hot-wire process evaluated previously. Explosion-tear tests on crack-starter specimens demonstrated that alpha-beta processed-base-plate withstands plate surface strains in excess of 6%, and weldments made by the three processes can endure strains in excess of 3% before propagating a crack. Mechanical properties, including strength, Charpy V-notch toughness, and dynamic-tear toughness, are similar for weldments made by the three processes. The results of the explosion-tear tests made in this investigation indicate that 6-pound pentolite charges are too severe for evaluation of 2-inch-thick Ti-621/0.8Mo weldments.

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HASSON, Dennis F., Assistant Professor, co-author, "Surfacing of 3.25% Nickel Steel with Inconel 625 by the Gas Metal Arc Welding-Pulsed Arc Process," Welding Journal (Research Supplement), 57 (January 1978), 1S - 8S.

The results of a metallurgical characterization of Inconel-625 weld-metal surfaced onto 3.25% nickel steel using the gas metal arc welding process are presented. It was found that Inconel-625 was directly weldable onto 3.25 nickel steel. Tensile properties were generally comparable to those for 3.25 nickel steel, and the most favorable mechanical properties were obtained with a heat input of 1.77 MJ/m (45 kJ/in.).

The corrosion fatigue-strength of the surface weld-metal at  $10^8$  cycles was found to be 10.34 MPa (15 ksi), which is lower than values reported for multiple pass Inconel-625 welds but is significantly higher than the corrosion fatigue strength of the steel. Fatigue-crack growth-rates for the surface weld-metal were found to be higher than the wrought Inconel-625 base metal and the steel.

The seawater corrosion resistance of the surface weld-metal was equivalent to the wrought base metal at levels of iron up to 9%, provided the molybdenum concentration was greater than 8%. Stress relief heat treatment did not degrade corrosion or fatigue properties.

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HASSON, Dennis F., Assistant Professor, co-author, "The Charpy V-Notch Test for Evaluation of High Strength Steel Extrusions," What does the Charpy Test Really Tell Us?, American Society for Metals, 1978.

Standard Charpy V-notch and 5/8-inch dynamic tear-tests were employed to assess the relative quality of three heats of 5Ni-Cr-Mo-V steel processed in the form of 1-inch-thick extruded plate. All materials were heat treated in the same manner to a yield-strength of 140 ksi (965 MPa), and each heat conformed to the chemical composition requirements for the 5Ni-Cr-Mo-V steel. Complete impact-energy versus temperature, transition curves for each heat in both the LT and TL orientations are presented. Single specimen J-integral tests were also performed at room temperature in both orientations. It was observed that the CVN test was just as effective as the 5/8-DT or  $J_T$  toughness measures in ranking metal quality in the TL orientation. In the high-toughness LT-orientation,  $J_I$  toughness-measures,  $J_{IC}$  and  $dJ/da$ , are more sensitive to metal quality than either the CVN or the 5/8-DT test. The CVN test was slightly less sensitive to directionality than the 5/8-DT or  $J_{IC}$ -toughness indicators. 5/8-DT tests indicated higher ductile-to-brittle transition temperatures than the CVN tests in the LT orientation, but this trend was not noted when the  $(CVN/\sigma_{ys})$  ratio was less than about 0.5, as in the TL orientation. The Rolfe-Novak-Barsom  $K_{IC}$ -upper shelf CVN correlation overestimated the  $(K_{IC}/\sigma_{ys})$  ratio compared to  $(K_{IC}/\sigma_{ys})$  ratios calculated from  $J_{IC}$ . This was attributed in part to the strain rate sensitivity of the material.

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HIRSCH, Richard A., Associate Professor, "Analysis of a Wave-Activated Turbine Generator Buoy System," USNA Report EW-13-77, September 1977.

The work previously reported in U. S. Coast Guard Report CG-D-57-76 has been continued to develop a linearized set of equations describing the buoy/water column dynamics. This model was to be validated using field-test data supplied by the Coast Guard but data was not available. The turbine/generator equations were validated by designing a test-stand to deliver air to the turbine and measuring the turbine output for various amplitudes and frequencies of air-input. The turbine/generator equations were found to accurately represent the performance and the system parameters were determined. An optimization study was performed, and it was found that the buoy system has an optimum water-column-length that maximizes the energy available to the turbine. This optimum length depends upon an equivalent viscous-damping coefficient which can be quantified if and when field test data becomes available. The overall energy conversion efficiency was found to be 2% when charging a 12-volt automobile battery.

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JOYCE, James A., Assistant Professor, co-author, "Elastic-Plastic Fracture Toughness ( $J_{IC}$ ) of High Strength Steels and Titanium Alloys," DWTNSRDC Report 78/054, June 1978.

The elastic-plastic fracture-toughness parameter  $J_{IC}$  has been determined for HY80, HY130, 10 Ni steel, 17-4 PH steel, and titanium alloys Ti-6Al-2Cb-1Ta-0.8Mo, Ti-7Al-2Cb-1Ta, and Ti-6Al-4V. Tests were carried out at room temperature by use of a multiple-specimen test method and a newly developed single-specimen computer interactive test procedure.  $J_I$  is shown to be an effective parameter in describing fracture toughness on the basis of both crack initiation and crack-growth resistance. The computer interactive-test-procedure is shown to produce equivalent results when compared with the multiple-specimen test method and possesses distinct advantages over that method.

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JOYCE, James A., Assistant Professor, "Single Specimen  $J_{IC}$  Testing of Navy Alloys," Final Technical Report submitted to National Science Foundation for Grant ENG 76-09623, November 1977.

This final technical report describes a computer interactive-method for determination of  $J_{IC}$  from a single specimen test. This method eliminates the need for the multi-specimen test procedure in use to date, greatly reducing the work involved in obtaining a  $J_{IC}$  value for a particular material and environment. Using this method  $J_{IC}$  values and the  $J_I$  R curve can be obtained as easily as can  $K_{IC}$ .

Data presented shows that  $J_{IC}$  obtained from single and multi-specimen tests are equivalent, though higher  $J_I$ -R curve-slopes are obtained for the single specimen when crack-tunneling occurs. Other results show that the  $J_I$ -R curve-slope depends strongly on specimen-thickness even when specimen-geometry satisfies the Paris-thickness-criterion though the  $J_{IC}$  value itself remains constant until the thickness criterion is violated. Additional tests show that blunt notches can cause a fourfold increase in apparent  $J_{IC}$  followed by a dramatic decrease of a factor of two in the  $J_I$ -R curve slope.

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KEATING, Eugene L., Assistant Professor, co-author, "Quasi-Equilibrium Air Standard Heat Balanced Cycle Analysis," Proceedings of the 1978 Intersociety Energy Conversion Conference, San Diego, California, (August 1978).

The Air Standard model of the cycle for the Naval Academy Heat-Balanced Engine (NAHBE) has been investigated analytically. The "ideal" thermodynamic or heat-balanced cycle was studied parametrically to determine the influence of changes in geometry and heat input on predicted indicated engine performance. Values for the cycle state points as well as mean effective pressure and thermal efficiency were obtained from the analysis as a function of variations in compression ratio and heat input. Comparisons are given with compatible Air Standard Otto and Diesel cycles. Results obtained for quasi-equilibrium indicate that for equal compression ratios and total heat input the heat-balanced cycle yields lower peak-pressures than the Otto cycle and with optimum geometry yields higher thermal efficiency than the Otto cycle. Equilibrium reduces to the classic dual cycle.

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LEE, William M., Associate Professor, co-author, "Periscope Bending Analysis," David W. Taylor Naval Ship Research and Development Center, Report No. SME 78-38, 1978.

An analysis of problems associated with excessive training-torques in non-power-assisted periscopes is made. Historical periscope/sail alignment data are also presented. The results indicate that, under misaligned conditions while underway, periscope turning torques can exceed specification requirements. The removal of one bearing to provide more system flexibility offers a short-term alternative. Recommendations for the use of low friction, self-lubricating bearings and a redesigned bearing support system are presented.

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WU, Chih, Associate Professor, "A Hydrogen Economy: Hydrogen as a Potential Naval Fuel," Alternative Energy Sources: A National Symposium, Miami Beach, Florida, 5-7 December 1977.

The feasibility of hydrogen as a potential fuel is determined by the availability and cost of hydrogen. This paper considers both the availability and production cost of hydrogen in view of its potential use by the U. S. Navy as a naval fuel. Hydrogen's implication on naval ships, aircrafts, and some special applications related to the Navy are also investigated.

It is apparent that our fossil fuel supplies are finite and will at some point cease to be an economic energy source. Among the alternative energy sources, which eventually we will turn to, hydrogen is an excellent candidate for the ultimate synthetic fuel. It is believed that in the distant future, a hydrogen economy makes sense. At what time, and in which uses, hydrogen becomes a realistic alternative to the more conventional techniques of energy distribution is dependent on the environmental, political, and economic values that our society sets for itself. However, because of these complex interactions with national values and fuel factors, significant use of hydrogen in the Navy could come only with the national adoption of a hydrogen-based economy.

A system analysis and production cost of hydrogen is made. A comparison of historical and future prediction of naval fuels (such as JP-5, JP-4, diesel) to hydrogen is studied. It is seen that although the current price of hydrogen far exceeds that of the distillate fuels used in the Navy, this may not be the case in 20 years.

Problems associated with using hydrogen as a naval fuel, such as fire and explosion hazard, storage, structural design, vessel size, range, operation, mission capabilities, etc. are discussed.

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WU, Chih, Associate Professor, "Experimental Investigation of Shipboard Facilities Maintenance and Manpower Utilization," David W. Taylor Naval Ship Research and Development Center Report, July 1977.

Fundamental concepts in experimental design for the investigation of shipboard facilities maintenance and manpower utilization are investigated. Experimental methods were conducted for reducing shipboard-maintenance manpower-requirements while improving the cleanliness and appearance of ships. Sample size, type I and type II errors, and analysis of variance were performed.

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WU, Chih, Associate Professor, "Potential Naval Applications of Direct Energy Conversion Devices," Proceedings of the 2nd National Conference and Exhibition on Technology for Energy Conservation, Albuquerque, New Mexico, 23-27 January 1978.

Direct-energy-conversion devices may be used as prime movers, refrigerating machines, etc. and are endowed with characteristics well-suited to diverse naval applications. Despite this, not much effort has been invested by the U. S. Navy in their development. There is a real and urgent need for substantial fundamental work in this area to be initiated. Developments of thermoelectric converters, thermionic generators, photovoltaic cells, MHD-systems and fuel cells are surveyed. A comparison between conventional energy conversion and direct energy conversion in size, weight, and efficiency is made. Potential utilization of these direct-energy conversion-devices to our Navy is studied.

Direct-energy-conversion is a new interdisciplinary field of engineering which is presently developing from the research work of engineers and scientists. Many devices possibly used in ship propulsion, submarine air conditioning, etc. use direct-energy-conversion principles and may evolve into direct energy converters. Other devices of less importance can also be found in this report, such as navigation buoys.

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WU, Chih, Associate Professor, "Potential Naval Applications of Thermo-Electric Energy Conversion Devices," Proceedings of the 2nd International Conference on Thermoelectric Energy Conversion, Arlington, Texas, 22-24 March 1978.

Over the past few decades many efforts have been devoted by the U. S. Navy to the development of new methods of generating thermoelectric power. These efforts were stimulated both by the discovery of new sources of energy, such as nuclear reactions, and by the increasing demand for electric power supplies that can meet special naval requirements of portability, compactness, low noise, long life, unattended operation, high efficiency, simplicity, maintenance free, and so forth. In these efforts some emphasis has been placed on the development of thermoelectric-energy-conversion devices, such as thermoelectric generators, magnetohydrodynamic generators, and thermionic converters, because the principles of their operation do not depend on the motion of mechanical parts. Compared with conventional turbo-alternators that involve rotating components, thermoelectric-energy-conversion devices were expected to be more reliable, longer-lived, and more compact. However, the thermoelectric energy conversion devices were virtually never used in practice until after World War II. Even today, these devices have found only a few commercial

applications because of their relative high cost compared with conventional devices. From the point of economics, it is seen that, other than in aerospace, the next application-fields are most probably in military and medicine. It is the attempt of this paper to highlight some of the potential naval applications for which thermoelectric energy-conversion-devices appear to be well-suited.



ADAMS, James A., Professor, "Computer Graphics in Mechanical Engineering," National ASEE Conference, Vancouver, British Columbia, June 1978.

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HASSON, Dennis F., Assistant Professor, "Simulation of Hot Spin Forming by Elevated Temperature Tensile Testing of a Near Alpha Alloy," Fall AIME Conference, Chicago, Illinois, 1977.

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HASSON, Dennis F., Assistant Professor, "The Charpy V-Notch Test for Evaluation of High Strength Steel Extrusions," TMS-AIME 107th Meeting, Denver, Colorado, February 1978.

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JOYCE, James A., Assistant Professor, "Computer Interactive  $J_{IC}$  Testing of Navy Alloys," ASTM Symposium on Elastic Plastic Fracture, Atlanta, Georgia, November 1977.

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JOYCE, James A., Assistant Professor, "Investigation of Specimen Geometry Modifications to Determine the Conservative  $J_I$ -R Curve Tearing Modulus Using the HY130 Steel System," 11th National Conference on Fracture - ASTM, Blacksburg, Virginia, June 1978.

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JOYCE, James A., Assistant Professor, "Progress Report on Single Specimen  $J_{IC}$  Testing Matrix (A533-B)," EPRI-NRC Meeting, Palo Alto, California, February 1978.

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JOYCE, James A., Assistant Professor, co-author, "Transverse Fracture Toughness of Graphite Aluminum Composites," Second Tri-Service Conference on Carbon Fiber Reinforced Metal Matrix Composites, U. S. Naval Postgraduate School, Monterey, California, 9-11 May 1978.

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KEATING, Eugene L., Assistant Professor, co-author, "Hydrogen Production from Nuclear Product Waste Heat and Use in Gas Turbines," 24th Annual Meeting American Nuclear Society, San Diego, California, June 1978.

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## NAVAL SYSTEMS ENGINEERING DEPARTMENT

*Professor Peter F. Wiggins, Chairman*

Research in the Naval Systems Engineering Department plays a vital role in the professional enrichment of both midshipmen and faculty. During Academic Year 1977-1978, faculty members and midshipmen participated in numerous and varied projects in the fields of marine engineering, ocean engineering, and naval architecture.

A variety of projects were undertaken, both funded and unfunded. These include faculty research in the areas of internal engine analysis, dynamic theory analysis, sediment shear-strength, wave-energy studies, hydromechanics laboratory development, energy conservation, ocean energy resources, neutron-activation studies, condenser studies, ship-stability studies, boundary-layer studies, ocean thermal-energy conversion, fission-fragment decay heat studies, environmental protection programs, and faculty-sponsored midshipman projects in the areas of undersea laboratory design and construction, advanced marine vehicles, hydrogen production, and heat transfer.

Support for research was found in many sources, from Departmental operating funds to contracts and grants from such diverse organizations as the Naval Academy Research Council, the Naval Sea Systems Command, the U. S. Coast Guard, and the David W. Taylor Naval Ship Research and Development Center.

Research and design projects, as in the past, have continued to display the originality and variety typical of the Naval Systems Engineering Department faculty and undergraduate majors. The Department will continue to pursue an aggressive commitment for research for the midshipmen and faculty that provides the needed scholarly activity to maintain an outstanding undergraduate program. Many of the faculty members of the Department are internationally known for contributions in their respective fields.

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## DIMENSIONAL ANALYSIS OF OCEAN THERMAL-ENERGY-CONVERSION HEAT EXCHANGERS

Researchers: Professor Arthur E. Bock and Associate Professor Martin E. Nelson

Sponsor: Naval Academy Energy/Environment Study Group  
(Navy Energy and Natural Resources R&D Office)

This study points out certain historical highlights and problems associated with development of electrical energy from deep-ocean thermal differences. Natural and economic factors which have forced attention on this type of energy development are mentioned, as well as areas of support by the National Science Foundation, the Energy Research and Development Administration (now DOE), and the U. S. Navy.

Dimensional analysis is used to develop a list of dimensionless groups having significance in OTEC (Ocean Thermal Energy Conversion) heat exchangers. Certain of these groups are then evaluated for a model and a prototype OTEC-type heat exchanger using the same working fluid and experiencing the same working fluid flow rate per unit area. A discussion of the evaluation and conclusions complete the report.

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## ENERGY AWARENESS

Researcher: Professor Arthur E. Bock

Sponsor: Naval Academy Energy/Environment Study Group  
(Navy Energy and Natural Resources R&D Office)

"Energy Awareness" is a presentation for midshipmen enrolled in the course EN300 - Naval Engineering II. The purpose of the presentation is to bring before the midshipmen problems faced by the country, by the Department of Defense, and by the Navy as a result of our ever-decreasing supply of domestic liquid fossil-fuels and the price increase levied on imported fossil-fuel by the OPEC countries. The presentation is arranged so that it may be given live with 35 mm slides, or by TV tape.

The presentation has an introduction which highlights the history of oil production and consumption, followed by 44 slides which graphically and pictorially tell who has the energy or raw materials (world-wide) and how fast it is being used. Also included is an account of the Navy's needs for fossil-fuels (liquid and gas) and what means it is using to conserve what supplies are available. Several slides spell out new energy sources, but also point out the time-frame in which they may be realized. The presentation closes with a number of conclusions.

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## AN EXPERIMENTAL STUDY OF TURBULENT BOUNDARY-LAYER WITH SLIT SUCTION

Researcher: Assistant Professor Sander M. Calisal

Sponsor: Naval Academy Research Council

Boundary-layer and its separation can be controlled by suction. It is also possible to relaminarize a flow by applying a suction or injection. The limits of relaminarization and the required amount of suction for relaminarization are of interest as they will decrease wall stress.

Experiments were performed on a flat plate with suction slit in the Reynolds number range  $5 \times 10^5 < Re < 1.110^6$ . Mean Velocity profiles, RMS values were measured with hot-wire anemometry. Friction velocity was numerically calculated. The experiments showed that a classical boundary-layer parameter  $\alpha$  with and without suction is related to the suction coefficient  $S_c$  with an equation of the form:

$$\ln\left(\frac{\alpha \text{ with suction}}{\alpha \text{ without suction}}\right) = A \cdot S_c + B \text{ for } 0 < S_c \leq 3 \text{ and } y^* > 10$$

General form of equation for velocity in the boundary-layer is, therefore, given in terms of integral relationship. The flow is not observed to relaminarize in the suction range used in these experiments. A numerical method based on finite analyses is currently under study.

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## HEAT TRANSFER STUDIES

Researcher: Assistant Professor William B. Huckenpoehler

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

Basic heat transfer studies and experiments for drag reducing polymers were carried out as part of an overall propulsion system analysis.

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## EVALUATION OF MEASURED HEAT-TRANSFER COEFFICIENTS IN AN EXPERIMENTAL OTEC HEAT-EXCHANGER

Researcher: Associate Professor Martin E. Nelson

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The David W. Taylor Naval Ship Research and Development Center is measuring heat-transfer coefficients in an experimental OTEC heat-exchanger to determine the effectiveness of different mechanical cleaning methods. The data collected are analyzed by two computer programs. Among the assumptions made in determining the heat-transfer coefficient are (1) fully developed heat transfer, (2) constant air heat transfer coefficient, and (3) negligible thermal effect of the filament heater. Additionally, the results are valid only for smooth tubes.

The effect of these assumptions and conditions on the measured heat-transfer coefficient in aluminum and titanium heat-exchangers have been analyzed by modifying the above computer programs.

It was found that since the thermocouples in the test-section are located at a point where the heat transfer is not fully-developed, that this leads to a 3.5% increase in the measured heat-transfer coefficient over a fully-developed heat-transfer coefficient. To calculate air heat losses, an air heat-transfer coefficient equal to  $1.57 \text{ BTU/hr ft}^2 \text{ }^\circ\text{F}$  had been assumed in the original computer program. However, if more detailed air heat-transfer losses by convection and radiation are considered, a change of 5-6% in the measured heat-transfer coefficient is found. Also, by incorporating the heater filament into the model, the measured heat-transfer coefficient is reduced by as much as 15%. Thus significant errors can be made in the measured heat-transfer coefficient if these effects are not considered. Other effects such as the uncertainty in the copper-cylinder-heater thermal conductivity have been studied, but found to be of less importance.

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## FLOW PATTERNS AND VELOCITY MEASUREMENTS IN A POWER-PLANT CONDENSER-WATERBOX

Researcher: Assistant Professor Clyde C. Richard

Sponsor: Naval Academy Research Council

The behavior of the flow found in a power-plant condenser-waterbox has been experimentally investigated. The configuration used consisted of a plastic, 1 to 13.6 scale-model of a nuclear-power-plant condenser-waterbox operating in a steady-flow test-loop. Separated flow and recirculation effects which began at the waterbox elbow and continued through the waterbox

to the tube-sheet were studied. Visual techniques using air bubbles and dyes demonstrated the location and nature of the flow-patterns. Velocity measurements were made in the regions of interest. A velocity-shift parameter was developed to quantify the magnitude of the flow separation and recirculation. Turning vanes were added in the waterbox elbow and subsequent measurements established their effectiveness in improving the flow hydraulics of the waterbox.

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SOME COMMENTS ON THE PIERSON MOSKOWITZ SPECTRUM OF THE SEAWAY

Researcher: Research Professor Manley St. Denis

Sponsor: Naval Sea Systems Command

The Pierson Moskowitz spectrum of the seaway is not related to a reasonable spectral width with the result that the mean period of the waves calculates to be infinitesimally small. This is obviously inconsistent. A modification to the P.M. spectrum is suggested that eliminates this inconsistency. It is based on:

- a. Elimination of the contribution of capillary waves.
- b. Introduction of the influence of viscosity on the profile of the spectrum in the region of low-spectral periods.

The results obtained with these corrections are quite plausible and appear to be consistent with expectations.

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APPLICATION OF A GENERALIZED DYNAMIC THEORY TO PHYSICAL SYSTEMS

Researcher: Lieutenant Commander Pharis E. Williams, USN

Sponsor: Naval Academy Research Council and Office of Naval Research  
(Code 438)

The objective of this investigation was to determine the field equations or the metrics coefficiently required by a set of adopted dynamical laws which form the basis of an original physical theory and to apply the results to a physical system.

The first step was to determine what requirements the adopted laws placed upon the new geometrics, then to use the requirements to determine the resulting metric. The second step was to study this metric in order to interpret any new terms so that application to a physical system might be determined.

The requirements of the adopted laws upon the metric were found to be sufficient to completely determine the geometry of the metric. This allowed a unique unification of the various branches of physics plus an extension of physical theory into five dimensions--space, time, and mass. This extension allowed the application of the theory to various physical systems, such as hydrodynamics, electrodynamics, and the self-energy of a charged particle.



THERMOMECHANICAL CHARACTERISTICS OF ALLOYS EXHIBITING MARTENSITIC THERMO-ELASTICITY

Researcher: Lieutenant Commander Robert R. Allen, USN

Successful application of unique mechanical effects related to thermo-elastic-martensite transformation, deformation, and reversion is discussed in terms of the requirements to characterize various unique thermomechanical parameters, such as reversion stress, strain limits, stress and strain stability, and cycling effects. The dependence of reversion stress on such factors as prestrain, partial relaxation during reversion, temperature, and time was evaluated for Ni-Ti-base alloys and recent data were correlated with existing data for NiTi and other "shape memory effect" alloys. The kinetics of martensitic deformation and reversion was discussed and related to proposed microstructural models for martensitic thermoelastic effects. Practical considerations such as stress relaxation, consequences of exceeding strain limits, and conditions for development of reversible effects were discussed. The general prerequisites for thermoelastic martensite effects were summarized, and implications regarding applications were discussed.

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AN INTACT HYDROSTATIC ANALYSIS OF YP 660

Researcher: Assistant Professor Bruce C. Nehrling

A technical report describes the development of hydrostatic curves of form and general stability diagram for current Naval Academy Yard Patrol Craft like YP 660. The description and results of an inclining experiment on YP 660 are included. Current U. S. Navy stability-criteria are applied to the ship and observations are made regarding the proposed open ocean employment of the Naval Academy YP's.

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WAVE ENERGY ATTENUATION BY AN ARRAY OF PNEUMATIC CONVERSION DEVICES

Researcher: Midshipman 1/C Roy Bookmiller

Adviser: Professor Michael McCormick

An experimental study was made to determine the energy transmitted past a series of three wave-energy-conversion devices. Three pneumatic devices were placed in-line normal to the wave direction. The air motion excited above the waves within each device was determined using hot-wire probes, while the wave heights and period were simultaneously recorded. These data were used to show significant wave attenuation in the transmitted wave.

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APPLICATION OF NEUTRON-ACTIVATION ANALYSIS FOR DETERMINING UNKNOWNNS

Researcher: Midshipman 2/C Robert Engel

Adviser: Assistant Professor Clyde C. Richard

Midshipman Engel was responsible for calibrating the neutron-activation analysis system with known quantities of trace metals. Lead, zinc, mercury, aluminum, and iron samples were activated and analyzed to determine their gamma spectrums. This work is the prelude to the project scheduled for next fall. Chesapeake Bay water samples from several locations will be studied using activation analysis to determine their contents of trace elements.

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VELOCITY AND TURBULENCE MEASUREMENTS IN A CONDENSER-WATERBOX

Researcher: Midshipman 1/C Daniel Holoubek

Adviser: Assistant Professor Clyde C. Richard

A preliminary measurement was made of the velocity and turbulence levels in a condenser-waterbox using a hot-film anemometer. Velocity calibration of the equipment was accomplished, using a steady-flow water channel and a laser anemometer.

Measurements in the waterbox indicated differences in the relative turbulence levels during radial traverser of the entrance region. Problems with fouling the probe-tip were encountered but solved by using a probe with a conical tip-shape upon which sediment and other foreign matter could not adhere.

A comparison was made between velocity measurements made with the hot-film anemometer and measurements made previously with a pitot tube. A satisfactory relationship between the measurements existed.

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#### NEUTRON ACTIVATION ANALYSIS OF HUMAN HAIR

Researchers: Midshipmen 1/C Edward F. Kamradt, Charles G. Wendt, and Michael Kozlarek

Adviser: Associate Professor Martin E. Nelson

The variation in the chemical composition of human hair was studied by neutron activation analysis. The hair samples were activated by 14.5 MeV neutrons produced in a sealed-tube neutron-generator. The generator at maximum yield produces approximately 11 neutrons/second. Thus high activity can be induced in samples in short periods of time. The resulting  $\gamma$  activity of the hair samples is counted using  $N_{AI}$  (Th) crystals. The chemical composition of the hair is determined by analyzing the hair's  $\gamma$  spectrum in a  $N_a I$ -activation analysis program developed by Tracor Northern.

The objective of this study was to determine whether neutron activation analysis of hair with a neutron generator and a  $N_{AI}$  crystal gives sufficient detailed chemical composition so that the result could be applied in forensics.

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#### FORCES ON THE MOORED MEDUSA

Researcher: Midshipman 1/C Stanley J. Labak

Adviser: Assistant Professor Sander Calisal

The purpose of this research is to estimate the magnitude and center of the forces acting on MEDUSA (an acronym for Midshipman-Engineered and Developed Underwater Studies Apparatus) in relative motion at sea. MEDUSA is expected to perform in the Chesapeake Bay, where tidal and density currents exist. To estimate the equilibrium and stability of MEDUSA in the bay it is, therefore, necessary to obtain the magnitude of the forces and moments for varying current direction.

A 1/6 scale model of the MEDUSA was built in the model shop and tested in the U. S. Naval Academy small towing-tank. Forty-two tests were performed with different mean speeds and relative angles of attack. The results indicate that, because of the interaction between components, total resistance coefficients are smaller than predicted by a linearized superposition method. But the estimated forces are large enough to harm the stability of the moored MEDUSA in an operational environment. Additional research to study interaction is recommended.

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## A COMPARATIVE STUDY OF NAVAL ESCORT HULL-FORMS

Researchers: Midshipmen I/C A. J. Quatroche and David B. Rigdon

Adviser: Associate Professor Roger H. Compton

Comparative effective horsepower in still water and vertical plane motions in regular head seas is determined from the testing of two five-foot escort ship models in the U. S. Naval Academy's Hydromechanics Laboratory. The experimentally-determined seakeeping results are compared with analytical results employing strip-theory.

Data taken manually and under computer control are compared. An attempt to relate performance differences to hull shape differences is made and described.

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## WAVE ENERGY CONVERSION BY RESONATING BODIES

Researchers: Midshipmen I/C Jack Richardson and John P. Coffey

Adviser: Professor Michael McCormick

This is an experimental study of the Budal-Fales effect which occurs when heaving bodies in resonance obtain energy from a wave crest width of  $\lambda/2\pi$ ,  $\lambda$  being the wavelength. The reason for the wave-focusing is the interaction of the radiated waves and incoming waves. Although the experimental results gave strong support to the theory, the facilities are too small for a definite test.

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BOCK, Arthur E., Professor, and Martin E. NELSON, Associate Professor, "Dimensional Analysis of Ocean Thermal Energy Conversion Heat-Exchangers," Report USNA-EPRD-33, June 1977.

The paper points out certain historical highlights and problems associated with development of electrical energy from deep-ocean thermal differences. Dimensional analysis is used to develop a list of dimensionless groups having significance in OTEC (Ocean Thermal Energy Conversion) heat-exchangers. Certain of these groups are then evaluated for a model and a prototype OTEC-type heat-exchanger using the same working fluid and experiencing the same working fluid flow rate per unit area.

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CALISAL, Sander M., Assistant Professor, "The Effect of Control Acceleration Ship Wave Patterns on Wave Survey Methods," Journal of Ship Research 21 (December 1977), 239-247.

Wave-resistance calculations based on wave-survey methods assume a constant ship velocity. The possible effect of initial acceleration are studied for different wave-survey methods and a procedure for determining the existence of an initial acceleration wave is proposed.

This paper presents a study to evaluate the effect of initial acceleration on the various existing wave survey methods and to determine which one is least affected by this possible source of error. The ship is represented by a distribution of sources and sinks.

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COMPTON, Roger H., Associate Professor, "Experimental Naval Architecture at the U. S. Naval Academy," Naval Engineers Journal, 89 (August 1977), 19-29.

This paper discusses the background of the Naval Academy curriculum leading up to the educational program now provided. It describes the experimental naval architecture curriculum now available to the midshipman, provides the goals established for experimental naval architecture, gives an account of the updating, reconfiguring, and recommissioning of the facilities to Rickover Hall that now support experimental naval architecture, and concludes with information regarding the future plans for new tests.

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COMPTON, Roger H., Associate Professor, co-author, "The U. S. Naval Academy Hydromechanics Laboratory Data Acquisition, Control, and Analysis System," Proceedings of the 18th American Towing Tank Conference (ATTC), August 1977.

This is a description of the computer-based system--hardware and software--designed for and incorporated in the USNA Hydromechanics Laboratory. Discussion of the operating philosophy and the resulting language developed for the system by USNA/CADCOM/CSC over the past several years is provided. Examples of terminal dialog, "quick look" and "report quality" output are given.

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DAWSON, Thomas H., Assistant Professor, "Dynamics of Towing Cables," Ocean Engineering, 4 (December 1977), 187-196.

The dynamic response of shallow, nearly horizontal, towing cables to periodic horizontal-end displacements is examined theoretically using the assumption that the shape of the dynamic deflections is of the same general form as the equilibrium shape. Virtual-work methods are used to determine the governing equation for the time dependence of the assumed deflections and an approximate analytic solution is obtained. Results from a typical example show that the analytic solution gives results that are generally within 10% of those found by direct numerical integration of the governing equation. When sufficiently large end displacements are considered, the analytic solution is found to yield an unstable description requiring net compressive loadings in the cable during part of its motion. In these circumstances, an approximate solution is indicated, based on the assumption that any small increment of compressive loading is quickly relieved by small cable motions which do not appreciably affect the shape of the dynamic deflections. Numerical results indicate that the maximum as well as the minimum value of the cable force is affected by instability even though it occurs only during part of the cable motion.

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JOHNSON, Bruce, Professor, co-author, "An Algorithm for Predicting Breaking Waves in a Towing Tank," Proceedings of the 18th American Towing Tank Conference, August 1977.

One problem associated with the generation of irregular waves for ship-model tests in a towing tank is the appearance of breaking waves somewhere in the wave train. This results in a redistribution of spectral energy in the generated wave-spectrum and causes the wave-energy to be non-stationary (time varying) in terms of spatial distribution in the tank. Many tank experimentors avoid this by using only low sea states for irregular wave tests or just quietly hope the problem won't be noticed for larger sea states.

The advent of computer-generated irregular waves raises the possibility of trying to predict whether or not breaking waves will occur in a specific wave-generator drive-signal. Although wave steepness (wave height/wave length) is difficult to define in irregular waves, wave slope can be derived from a wave record which consists of a sum of sinusoids with or without random phase. For regular waves the ratio of maximum wave slope to "wave steepness" is equal to  $\pi$ . This randomized sum of sinusoids technique involves the knowledge of the wavemaker transfer function (amplitude and phase) and an analytical description of the proposed drive signal.

A wave-breaking predictor is attractive in that a proposed drive-signal can be tested for the possibility of breaking waves without having to generate the actual waves in the tank once an experimentally-determined maximum wave-slope has been established. This greatly reduces the calibration time required for a new wave spectrum specified for a given test.

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JOHNSON, Bruce, Professor, co-author, "A Computer-Controlled Wave Generation System for the U. S. Naval Academy," Proceedings of the 18th American Towing Tank Conference, August 1977.

The problem of generating a "random" signal of specified spectral content has been attacked in many areas of test engineering. In some cases, the statistical problems have been resolved through the use of digital techniques, and random-testing procedures have become quite common. In other areas, such as towing-tank testing, however, the use of random waves is limited by several problems. The non-linearity of many wave generators makes it quite difficult to control spectral shape accurately, and statistical reproducibility is adversely affected by breaking waves, beach reflections, and the relatively short duration of most tank tests.

A computer-controlled wave-generation system has been designed and tested at the U. S. Naval Academy Hydrodynamics Laboratory which attempts to resolve several of these problems. This system, which drives the servo-hydraulic dual-flap wavemakers in the 380' and 120' towing tanks as well as the single-flap wavemaker in the Coastal Engineering tank, is capable of generating single-frequency, multiple-frequency, random or pseudo-random waves with a specified spectral content. The system has a demonstrated capability to generate the constant amplitude/constant slope wave-spectrum proposed at the 17th ATTC by Johnson and used by Springett, Chen, and Blewer in tests of offshore platforms.

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JOHNSON, Bruce, Professor, and Bruce NEHLING, Assistant Professor, Editors, Proceedings of the 18th American Towing Tank Conference, U. S. Naval Academy, August 1977.

The Proceedings contain the collected papers of the conferences in the areas of Resistance and Flow, Propulsion, Seakeeping, Cavitation, Maneuvering, and Systems and Techniques. It comprises 850 pages in three volumes.

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MCCORMICK, Michael E., Professor, "Wind-Wave Power Available to a Wave Energy Converter Array," Ocean Engineering, 5 (1978), 67-74.

A theoretical expression of the wave power striking a rectilinear array of wave energy converters in a random sea is presented. Results of the analysis show that previous analyses overestimated the power converted by 25% under the optimum design conditions. Furthermore, no power was previously predicted under the off-design condition, while the present analysis predicts 33% of the maximum under this condition.

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MONNEY, Neil T., Associate Professor, "Energy from Salinity Gradients," ASME Special Publication, OED, Vol. 4, Ocean Energy Resources, (September 1977), 33-42.

A major untapped source of energy exists where there is mixing between waters of different salinities. The problem is to convert this free energy of mixing between solutions of different salt concentrations into useful energy. The energy exists in the osmotic pressure difference between the two solutions. Osmosis is the transport of a solution through a semipermeable membrane separating two solutions of different solute concentration. The fluid diffuses through the membrane from the solution that is diluted in solute to the solution that is concentrated. The flow occurs as a result of the thermodynamic tendency to achieve equilibrium of the solute concentration on both sides of the membrane. The flow through the membrane can be stopped by applying pressure to the liquid on the side of higher solute concentration. The osmotic pressure-head between fresh water and seawater is approximately 240 m. (787 ft). This is about the same height as the total number of dams constructed to produce electricity on the Columbia River. Thus the quantity of energy being extracted from the Columbia River as hydroelectric power is similar to that being lost in the free mixing of the fresh water and the seawater at the mouth of the river. Other highly saline bodies of water such as the Dead Sea, the Great Salt Lake, and salt marshes could be used to

produce energy from salinity gradients. The average salinity of the oceans is about 3.5%, but the Dead Sea has a salinity of over 26%, which represents an osmotic pressure head of over 3000 m. (9840 ft.) at the mouth of the Jordan River. Water with even higher salinity could be maintained by mixing seawater with the vast deposits of dry salts on land. Each of these potential sources of energy is essentially a form of solar energy, as they depend on the sun for evaporation to produce the salinity gradients. The potential energy available from major sources of salinity gradients throughout the world is assessed and alternative means of extracting the energy are evaluated.

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MONNEY, Neil T., Associate Professor, "Ocean Geothermal Energy," ASME Special Publication, OED, Vol 4, Ocean Energy Resources, (September 1977), 69-82.

Except for the relatively thin crust of the earth, which forms the land surface and ocean floor, the entire volume of the earth is very hot. This enormous reservoir of geothermal energy, about 1019 billion cubic kilometers (259 billion cubic miles) of primeval heat, represents the largest source of energy now available to man. Theoretically, this energy source can be tapped by drilling deep enough into the crust of the earth to provide a passage for a heat-transfer fluid which will extract the heat. Realistically, this hot mass of material generally lies far too deep to be reached with existing drilling capability. The depth to the base of the crust under the continents averages about 35 kilometers (22 miles). In the coastal zone, the depth is about 5 kilometers (3 miles), and under the ocean basins, about 3 kilometers (2 miles).

There are many zones in the earth's crust, however, where the molten rock (magma) has pushed upward, through or near the surface of the earth, bringing the heat to a point where it can be used by man. Although very few of these zones have a heat flux great enough to keep up with man's use of the heat once a reservoir is tapped, and thus they are not "renewable" energy sources except on a geological time scale, the quantities of stored energy are very great and in some cases could yield energy for several hundred years. The geothermal zones are abundantly evident on land in the form of volcanoes, geysers, hot springs, and fumaroles (vapor emissions). Many other similar "hot spots" exist without surface evidence. If the heat in these zones could be effectively harnessed, it would meet the total energy requirements of the United States for the foreseeable future. Unfortunately, there are many problems associated with extracting the energy which will limit or delay the full potential of the development of geothermal energy. Because of the uncertainty involved in solving some of

these problems, there is very little agreement about how much of this energy resource can be developed by the year 2000. In any case, there is a great deal of energy available. These estimates, however, do not include ocean floor geothermal energy. Geological evidence indicates there is even more geothermal energy available from ocean floor resources. This paper describes those resources and the technical problems involved in tapping the resource.

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RICHARD, Clyde C., Assistant Professor, and Robert F. LATHAM, Associate Professor, "The Use of Gas Turbine Laboratories in Teaching Engineering and Non-Engineering Students," Transactions of Gas Turbine Division of the American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, London, England, 9-13 April 1978.

The United States Navy has committed itself to gas-turbine power systems for a number of its present-day ships. Although gas turbine theory and practice have long been a part of the curriculum at the U. S. Naval Academy, it recently has become essential to expand classroom and laboratory programs. The graduating naval officer, regardless of educational major, must have a background that familiarizes him not only with the theory of gas turbines, but with the actual running of such machinery. Special problems associated with applying gas turbines to shipboard conditions must be understood and appreciated. This paper traces the history of the use of gas turbine laboratories in supporting classroom work at the U. S. Naval Academy. Two levels of educational effort are addressed: (a) gas turbine theory and laboratory exercises for the engineering major, and (b) gas turbine theory and laboratory exercises for the non-engineering major. Programs for both classes of students are explained including sample laboratory exercises and typical results.

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WIGGINS, Peter F., Professor, co-author, "Beryllium Reflected Coal Analytical Assembly using  $^{252}\text{Cf}$  Neutron-Capture Gamma Rays," Transactions of the American Nuclear Society, 27 (1977), 163.

The neutron interrogation of process-streams containing coal, chemicals, and catalysts, and measurement of the resulting gamma rays, is proposed for composition monitoring in coal-gasification and liquefaction plants. The neutrons can be moderated for absorption by the H and C in the streams, which will probably be at high temperatures and pressures in heavy pipes. Limiting the materials in any analytical assembly to those with low neutron absorption, and of less interest in coal, is desirable. Hence, Be, an excellent neutron-reflector, was used in an experimental assembly.

Coal in an annular 9-in.-diam. x 9-in.-high Al can was irradiated by neutrons from  $^{252}\text{Cf}$  in the can's bottom center. This Be-unit extended an earlier design having boric acid outside the cavity; the boron reduced the contribution to the signal from non-coal elements but absorbed all neutrons escaping the coal.

Neutron flux measurements in the coal by Mn foils (1/2 in. diam. x 5 mil.) showed an average of  $10^5 \text{ n/cm}^2 \cdot \text{s}$  from  $60 \mu\text{g } ^{252}\text{Cf}$  ( $1.5 \times 10^8 \text{ n/s}$ ). The flux varied significantly over the sample volume; the ratio of the maximum ( $1.5 \times 10^5 \text{ n/cm}^2 \cdot \text{s}$ ), which was at the annulus center 3 to 4 in. from the  $^{252}\text{Cf}$ , to that at the can's side was about two. This ratio was about six with the boric-acid design. The average thermal-neutron level in the coal was more than doubled by the Be.

The gamma spectra were collected with a Ge(Li) detector about 3 feet from the coal. About 20 in. of Be protected the detector from fast neutrons, and  $^{10}\text{B}$  power surrounded the snout of the Ge(Li) crystal to absorb thermal neutrons.

In summary, a Be-reflected assembly is useful in experimental studies. Although Be is expensive, and requires toxicity precautions in fabrication, favorable nuclear and high-temperature properties may make it useful in a compact on-line analytical assembly. Finally, the results are favorable to the use of gamma rays from the capture of neutrons from  $^{252}\text{Cf}$ , or an accelerator, in monitoring the streams through pipe walls in coal conversion plants.

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WIGGINS, Peter F., Professor, "Energy Calibration for Capture Gamma Measurements with Coal," Bulletin of the American Physical Society, 23 (1978), 558.

Since the capture gamma energies of interest with coal are higher than decay standards, calibration of detectors must be with capture lines of coal and accompanying materials of the analytical unit. Also to retain sensitivity, it is desirable to minimize in the unit's structure the elements of coal. Fortunately, the coal itself thermalizes the neutrons for capture. Hence, for analytical units built with  $\text{Cf}^{252}$  and accelerator neutron sources, Be was the neutron reflector, B and Pb the neutron and gamma shields, and Al the supporting structure. Their capture energies (with single and double escapes) useful for calibration are: Al, 7724 KeV; Pb, 7368; Be, 6910 and 3368; and B, 478. From the coal, the Fe lines at 9828 and doublet at 7464 and 7632, are particularly useful; also the N, 10838, the highest energy, and H, 2223, the most intense line, may assist in instrument stabilization. In summary, significant capture lines for detector calibration are available from analytical units which might serve planned coal conversion plants.

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WILLIAMS, Pharis E., Lieutenant Commander, USN, "The Principles of the Dynamic Theory," Engineering and Weapons Report 4-77, June 1977.

Generalizations of the classical Thermodynamic Laws are adopted as the fundamental principles of the proposed theory, hereafter the Dynamic Theory. An important role is played by an integrating factor which makes the energy exchange with the environment a total differential and leads to the definition of a mechanical entropy. The integrating factor is shown to be a function of velocity only and an argument following Caratheodory's proves the existence of a unique limiting velocity which makes its appearance in the integrating factor.

Equilibrium and stability conditions for dynamic systems are derived and together with the principle of increasing entropy provide a geometrical structure from which the theories of relativity, Maxwell's electromagnetism, and quantum effects may be derived. Thus the Dynamic Theory is shown to unify the various branches of physics into one theoretical structure.

Extensions of current physical theories required by the Dynamic Theory are displayed. In these extensions new field quantities appear that become important for systems with varying mass density.

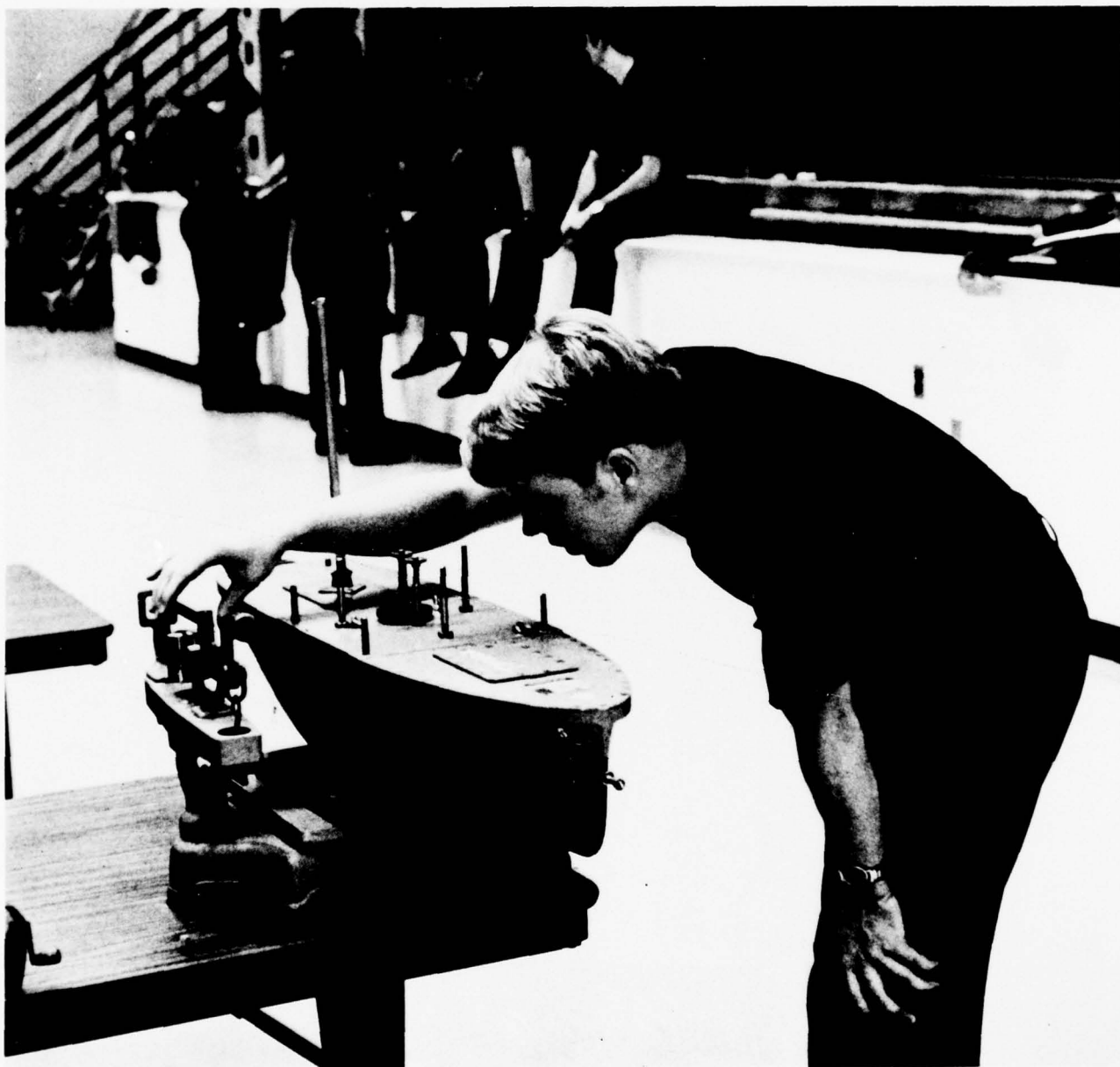
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WILLIAMS, Pharis E., Lieutenant Commander, USN, "The Dynamic Theory, a New View of Space, Time, and Matter," Engineering and Weapons Report 6-78, March 1978.

The proposed Dynamic Theory adopts generalizations of the three classical thermodynamic laws and is shown to produce a unique unifying effect by displaying that the fundamental principles of Newtonian and relativistic mechanics, Einstein's General Theory, Maxwell's electromagnetism, thermodynamics, and quantum effects occur as special cases. This not only reduces the number of fundamental assumptions but presents a new view of the interrelationship of the different branches of physics.

The Dynamic Theory also provides reasons to support the necessity of extending the dimensionality of the world-view to five dimensions; space, time, and mass. It is shown that the fifth dimension produces seven Maxwell-type equations containing new field quantities giving rise to a prediction of anomalous magnetic moments for neutrons and protons. The quantization of the five-dimensional world-view predicts the existence of three spin vectors, (two three-component and one four-component) which require octets as the allowed set of component eigen-values for fundamental quantum numbers and gives support to the hope of typing elementary particles to fundamental principles in a new way.

Other predictions of the theory include reduced pressures in an electromagnetically contained ionized plasma, the possibility of zero radiation pressure boundary conditions for the cosmos, the existence of a generalized entropy principle which includes General Relativity, thermodynamics, and quantum principles. The theory also predicts the existence of a limiting rate of mass conversion which is fundamentally the equivalent of the limiting velocity and temperature of relativistic and thermodynamic theories as well as providing the means to predict the self-energy of a charged particle.



PRESENTATIONS

NAVAL SYSTEMS ENGINEERING DEPARTMENT

COMPTON, Roger H., Associate Professor, co-author, "The U. S. Naval Academy Hydromechanics Laboratory Data Acquisition, Control and Analysis System," 18th American Towing Tank Conference (ATTC), Annapolis, August 1977.

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JOHNSON, Bruce, Professor, co-author, "An Algorithm for Predicting Breaking Waves in a Towing Tank," 18th American Towing Tank Conference (ATTC), August 1977.

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JOHNSON, Bruce, Professor, co-author, "A Computer-Controlled Wave Generation System for the U. S. Naval Academy," 18th American Towing Tank Conference, Annapolis, August 1977.

\*\*\*\*\*

JOHNSON, Bruce, Professor, "The New Naval Academy Model Basin," Ship Performance Department Hydromechanics Colloquium, David W. Taylor Naval Ship Research and Development Center, 19 January 1978.

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LATHAM, Robert F., Associate Professor, Comments on paper entitled "U. S. Flag Fleet Machinery Operations--Past, Present, and Future" by M. David Burghardt, Symposium on Sustaining Design Thermal Performance of Ship Propulsion Machinery, Sponsored by Institute of Marine Engineers at the United States Merchant Marine Academy, National Maritime Research Center, 9 February 1978.

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RICHARD, Clyde C., Assistant Professor, and Robert F. LATHAM, Associate Professor, "The Use of Gas Turbine Laboratories in Teaching Engineering and Non-Engineering Students," Gas Turbine Division of the American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, London, England, 9-13 April 1978.

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WIGGINS, Peter F., Professor, "Beryllium-Reflected Coal Analytical Assembly Using  $^{252}\text{Cf}$  Neutron-Capture Gamma Rays," 1977 Winter Meeting of the American Nuclear Society, San Francisco, California, November 1977.

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## WEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

*Associate Professor Charles F. Olsen, Chairman*

The Weapons and Systems Engineering Department provides and maintains an environment in which research activities contributing to the professional growth of the faculty and outstanding midshipmen flourish. Such research, in addition to keeping both faculty and midshipmen abreast of today's rapidly advancing technology, ultimately improves the academic environment by providing examples of, and solutions to, existing problems. Where research is based on problems posed by the U. S. Navy, the association causes the academic environment to be more relevant to the professional development of midshipmen.

Faculty research is regularly undertaken by nearly all civilian members of the Weapons and Systems Engineering Department and on occasion by some military members as well. Funding for research activities is available from several sources, including grants or contracts from various federal agencies as well as funding support from within the Naval Academy. Current contracts have been made by faculty members with both the Naval Electronics Systems Command and the Naval Air Development Center. Excellent faculty and midshipmen research relations have additionally been established with the David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory.



UHF SATCOM INTERMODULATION STUDY

Researcher: Assistant Professor C. George Brockus

Sponsor: Naval Electronics Systems Command

Compatible families of UHF frequencies were used in the past for tactical communications. These families were free from intermodulation products through the seventh order. The advent of satellite communications systems brought with it the problem of additional interference, not only for the satellite communications systems but for the tactical situation as well.

A set of computer programs was developed to enable the generation of new compatible families. These families were to be afforded the previous protection from intermodulation products through the seventh order, with the constraint that certain satellite uplink frequencies must be preserved in the families. In addition, the same protection from interference must be provided for the satellite downlink frequencies in use.

The project reached successful completion when typical families were generated for the various combinations of satellite communications systems in use.

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TARGET-STATE ESTIMATOR INVESTIGATIONS

Researcher: Assistant Professor Robert DeMoyer, Jr.

Sponsor: Naval Surface Weapons Center, Dahlgren Laboratory

Target-state estimation is a technique for estimating target position, velocity, and acceleration for use by a gun fire-control system. This research has helped to evaluate a new technique in comparison to more well-established techniques. Aside from qualitative discussions, quantitative evaluations are made of the degradation in accuracy due to sub-optimal approximations.

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A GENERAL PURPOSE FLUID/LOGIC POWERED GRIPPING MECHANISM FOR TELEOPERATORS AND ROBOTS

Researcher: Assistant Professor Kenneth A. Knowles, Jr.

Sponsor: Naval Academy Research Council

A preliminary study has been made to determine a set of basic end-effector movements, or sel (standard effector lexicon). In addition, a set of multipurpose end-effector tasks has been chosen as a design constraint for a general purpose robot or teleoperator end-effector. Concurrent prototyping studies of several fluid logic-controlled sequential devices have proven the feasibility of utilizing fluid logic for controlling and partially automating fluid-powered end-effectors. A prototype design is presently being finalized for a fluid-powered general purpose gripping device specifically tailored for use with underwater manipulators. Emphasis is being placed on simplicity of construction, while maximizing versatility. The prototype end-effector will be constructed utilizing existing low-cost fluid-logic and fluid-power devices (such as Clippard, Bimba, Visilogic, etc.). Crude touch and proximity sensors will be incorporated into the prototype end-effector with sufficient self-contained fluid logic to permit autonomous reflex maneuvers.

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OBSERVER DESIGN FOR IMPROVED RATE SENSOR PERFORMANCE

Researcher: Assistant Professor E. Eugene Mitchell

Sponsor: Naval Air Development Center

The automatic controls division of the Naval Air Development Center, (NADC) of Warminster, Pennsylvania, is currently investigating the use of the Model 8160 rate sensor offered by the inertial division of Systron Donner, Concord, California. This rate sensor appears to have the potential for reduced maintenance cost over current models; however, its output response has zero transmissibility at zero frequency, and NADC wanted to determine if this response could be altered through use of a filter.

An identity observer was designed to function as a state estimator for the rate sensor. Once the system states were available, the output of the observer was modeled after a desirable response. The resulting observer output performance exceeded expectations.

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DYNAMIC MODEL OF A COGAS PROPULSION SYSTEM

Researcher: Assistant Professor Jerry W. Watts

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The Navy is currently investigating waste heat recovery from stack gases as a source of energy to drive a steam turbine for additional main ship propulsion. The David W. Taylor Naval Ship Research and Development Center currently has a computer model (equilibrium and dynamic capability) of a gas turbine engine. The object of the present research is to develop a computer model of the combined steam and gas (COGAS) system. This model will be able to determine operating points and dynamic transients and will assist in the ongoing development of the COGAS system for ship propulsion.

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MICROPROCESSOR-BASED DIGITAL CONTROL OF ENVIRONMENTAL SYSTEMS

Researcher: Midshipman 1/C Eddy D. Kee

Advisers: Assistant Professor E. Eugene Mitchell and Major Richard W. Kopka, USAF

Sponsor: Trident Scholar Program

Recent advances in semi-conductor technology have led to the development of integrated circuit "chips," capable of performing a multitude of logic functions, and available at relatively low prices and in readily adaptable configurations. The current trend in integrated circuit manufacturing is toward smaller, more complex chips at ever lower prices. The microprocessor is a result of this trend. Midshipman Kee investigated the use of commercially available microprocessors in environmental control systems, including investigations of cost effectiveness, energy conservation potential, and functional effectiveness of microprocessor-based control systems when compared with conventional, thermostatically-controlled systems.

Midshipman Kee's investigation focused on the control of the environment within a small, non-commercial structure (represented by an analog/hybrid computer simulation) using a microprocessor based control device. The control device was programmed to reduce energy consumption while maintaining a comfortable temperature within the structure. With appropriate interface hardware and programming, such a device would be capable of controlling the environment within a wide range of structures.

An analysis comparing the performance of microprocessor based environmental control systems with that of conventional, thermostatically controlled systems was conducted. Midshipman Kee believes that a significant reduction in energy consumption, and therefore in costs, would result from the use of microprocessor-based systems in place of conventional systems. Additionally, he also notes the wide range of other control functions that could be performed at low cost by the microprocessor-based unit in a time-sharing mode, an impossibility with conventional, thermostatically-controlled systems.



## PERCEPTION MODELS IN HAND REHABILITATION

Researcher: Associate Professor Olaf N. Rask

The model of the process by which the shape of hand-held objects is perceived is of considerable interest to those interested in rehabilitating victims of hand injuries and hand surgery. To test this process, the researcher has generated metal shapes with given spatial-frequency distributions. The purpose is to study in a quantitative manner the empirical facts associated with the two-point test used in hand rehabilitation. The investigation with actual patients will begin in early June.



MICROPROCESSOR CONTROL SYSTEMS

Researchers: Midshipmen 1/C Thomas S. Crowley, William M. Dunkin,  
David R. Heinz, and Michael J. Holden and  
Midshipman 2/C Chester W. Wong

Advisers: Assistant Professors E. Eugene Mitchell and C. George Brockus

Five SDK-80 kits were assembled. These microcomputers are based on the Intel 8080 and come with a serial interface for terminal communications. An onboard monitor permits immediate programming in hexadecimal format.

Software was developed to permit the use of the microcomputers as sampled data controllers for continuous physical systems. The software included an interrupt-handler for a real-time clock, to enable periodic sampling; a multiplication routine for two byte numbers; a two's complement routine; a handler for the A/D converter; a handler for the D/A converter; and the main control algorithm to compute the Z-transform control equations.

The principal hardware problems were the A/D and D/A boards and the interface to that board, and the millisecond clock.

Programs were assembled on the DTSS, down-loaded via the Tektronix 4051 system, and eventually burned into PROM to be permanently resident in the SDK-80. Control problems were then run with a TR20 analog computer.

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MICROPROCESSOR-CONTROL OF LOW-SPEED VSTOL FLIGHT

Researcher: Midshipman 2/C Robert V. Walters

Adviser: Assistant Professor E. Eugene Mitchell

Midshipman Walters will be a Trident Research Student for the Academic Year 1978-1979. This project was the study of the application of a microprocessor to the stability-augmentation system of the AV-8B Harrier, a VSTOL aircraft.

The purpose of this research course was to perform the literature search necessary for the Trident Project.

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BETTIS, Jerry R., Major, USAF, et al., "Hydroxyl Influence and Refractive Index Dependence in Picosecond Thin-Film Damage," Laser Induced Damage in Optical Materials: 1977, National Bureau of Standards Special Publication.

Results of a study of the influence of OH<sup>-</sup> content of silica substrates on the damage-resistance of thin films under 1.06- $\mu$ m, 150-ps pulse illumination are presented. The OH<sup>-</sup> content variation was provided by the use of four types of commercial silica (Suprasil-W1, Optosil-2, Homosil, and Suprasil-1) as substrates. The OH<sup>-</sup> concentrations, as indicated by IR-absorption spectroscopy, are approximately 5, 130, 130, 1200 ppm, respectively. For each of the substrate materials, a set of four samples was made by depositing  $\lambda/2$  (at 1.06  $\mu$ m) films of ZrO<sub>2</sub>, SiO<sub>2</sub>, ThF<sub>4</sub>, and MgF<sub>2</sub>. Furthermore, an uncoated but otherwise identical sample of four uncoated silica materials was tested to provide baseline surface damage data. The results of this study are discussed in regard to earlier work of House, et al., concerning hydroxyl chemistry at film-substrate interfaces. A new interpretation of the role of OH<sup>-</sup> in the breakdown process for nanosecond and picosecond pulses is introduced.

A second important aspect of this study is the correlation of thin-film damage threshold with film material refractive index. On each substrate type, films covered the index range of 1.37 to 2.0. The threshold range observed in this picosecond study is discussed with regard to possible improvements in coating damage thresholds by use of low-index materials.

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BROCKUS, C. George, Assistant Professor, "UHF SATCOM Intermodulation Study," Report EW-8-77 (DDC Report No. ADB021556L), September 1977.

The advent of satellite communications systems, in which wideband receivers were utilized, brought problems for tactical communications systems. In the past, compatible families of frequencies were utilized in tactical situations. Those UHF-families were selected to afford protection from interference caused by intermodulation products through the seventh order.

It was necessary to afford protection for the new downlink frequencies of various satellite systems, and to maintain certain uplink frequencies in the families for transmission. It was necessary, therefore, to provide the same protection from intermodulation products through the seventh order for compatible families under new constraints and in varying circumstances.

A set of FORTRAN programs was developed to produce the compatible families. Several typical families of frequencies were generated with those programs for each of several cases in which different satellite systems were in use.

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KEE, Eddy D., Midshipman 1/C, "Microprocessor-based Digital Control of Environmental Systems," Trident Scholar Project Report Number 92, (1978), U. S. Naval Academy, Annapolis.

This project investigated the use of microprocessors and associated hardware to control the heating of a building in order to save energy. A house was simulated on the hybrid computer and controlled by a microprocessor-based digital controller. The work includes the mathematical model, simulation, flow charts, computer programs for controller, etc. to use for different type of houses and insulations. Tests showed that a significant amount of energy was saved by using the controller, as much as 30-50%, depending on the use-habits of the house.

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KNOWLES, Kenneth A., Assistant Professor, "The EAI MiniAC Analog/Hybrid Computer and a First Course on Systems Simulation," Electronic Associates Incorporated Application Notes, 1977.

Experience has shown that the analog simulation material is not only highly motivational, but it provides the student with valuable insights into the behavior of real systems. Non-linear systems in particular, which are often beyond the analytical capabilities of the student at this stage of his intellectual development, can easily be simulated, thus demonstrating explicitly such phenomena as regions of stability, limit cycles, etc.

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MITCHELL, E. Eugene, Assistant Professor, and C. George BROCKUS, Assistant Professor, "A Laboratory Digital Controller Based on the 8080 Micro-computer," Report EW-3-78, May 1978.

A project was undertaken by five midshipmen in ES495 to construct laboratory hardware to be used as sampled-data controllers for continuous-time systems. Intel 8080 microprocessors formed the heart of the system, assembled from kits as the SDK-80 microcomputer. The onboard monitor and serial interface permitted immediate programming capability in hexadecimal format.

A printed circuit board was developed to give A/D and D/A conversions, and interfaced with the computer. A one-millisecond clock was built on the computer board in order to mechanize sampling at regular intervals.

Software was developed, the principal components being: D/A and A/D handlers; the clock-interrupt handler; a multiplication routine for two-byte numbers; a two's complement routine; and the main program, a Z-transform control algorithm.

Assembly of the programs was done on the DTSS. Programs were downloaded with the use of the Tektronics 4051, and when run successfully on the microcomputer were burned into PROM to be permanently resident on the SDK-80.

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MITCHELL, E. Eugene, Assistant Professor, "A Survey of Active Machine Tool Control," Proceedings of the 1977 Joint Automatic Control Conference, pp. 512-520, (Presented at the 1977 JACC Conference).

The purpose of this paper is to present a survey of active machine-tool control, where active machine-tool control is the use of feedback to regulate the position of the cutting tool with respect to the workpiece on a machine, such as a lathe. The first such system was reported in 1968; the most current was reported on in 1975. One of the objectives of this survey is to see where this seven-year effort has gone, what has been accomplished, and what is likely to happen in the future.

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MITCHELL, E. Eugene, Assistant Professor, "Design of a Hardware Observer for Active Machine Tool Control," Transactions of ASME Journal of Dynamic Systems, Measurements and Controls, 99 (December 1977), 227-232.

Observer theory is applied to design an active controller for a machine tool such as a lathe to reduce the chatter-tendency and forced-vibration effects that can be detrimental to workpiece surface finish. An observer is used to estimate difficult-to-measure relative motion between the cutting tool and workpiece. The estimated motion is used in conjunction with measured states in a second application of observer theory to design a control system that causes the cutting tool to track the workpiece, negating relative vibratory motion. Hence, the entire control system with the cutting tool position as an output is an observer of workpiece motion. Stability of the controlled system as a function of mismeasurements of dynamical parameters and its ability to

reduce forced vibration effects are discussed. Performance calculations are based on a second order machine tool-workpiece dynamical model; however, the presented methods of design and analysis can be extended to higher order systems.

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MITCHELL, E. Eugene, Assistant Professor, "Frequency Response Calculations on a Programmable Calculator," SIMULATION, 29 (July 1977), 21-24.

This paper describes an algorithm with which the user can compute frequency responses on a small programmable calculator. Inexpensive calculators like the Hewlett-Packard 25 allow such calculations for a system containing as many as four poles and zeros. The user must enter the proper sequence for a pole or zero, but the process is simple; the user does not have to depend on and wait for a large computer. The paper presents the solution of a typical problem.

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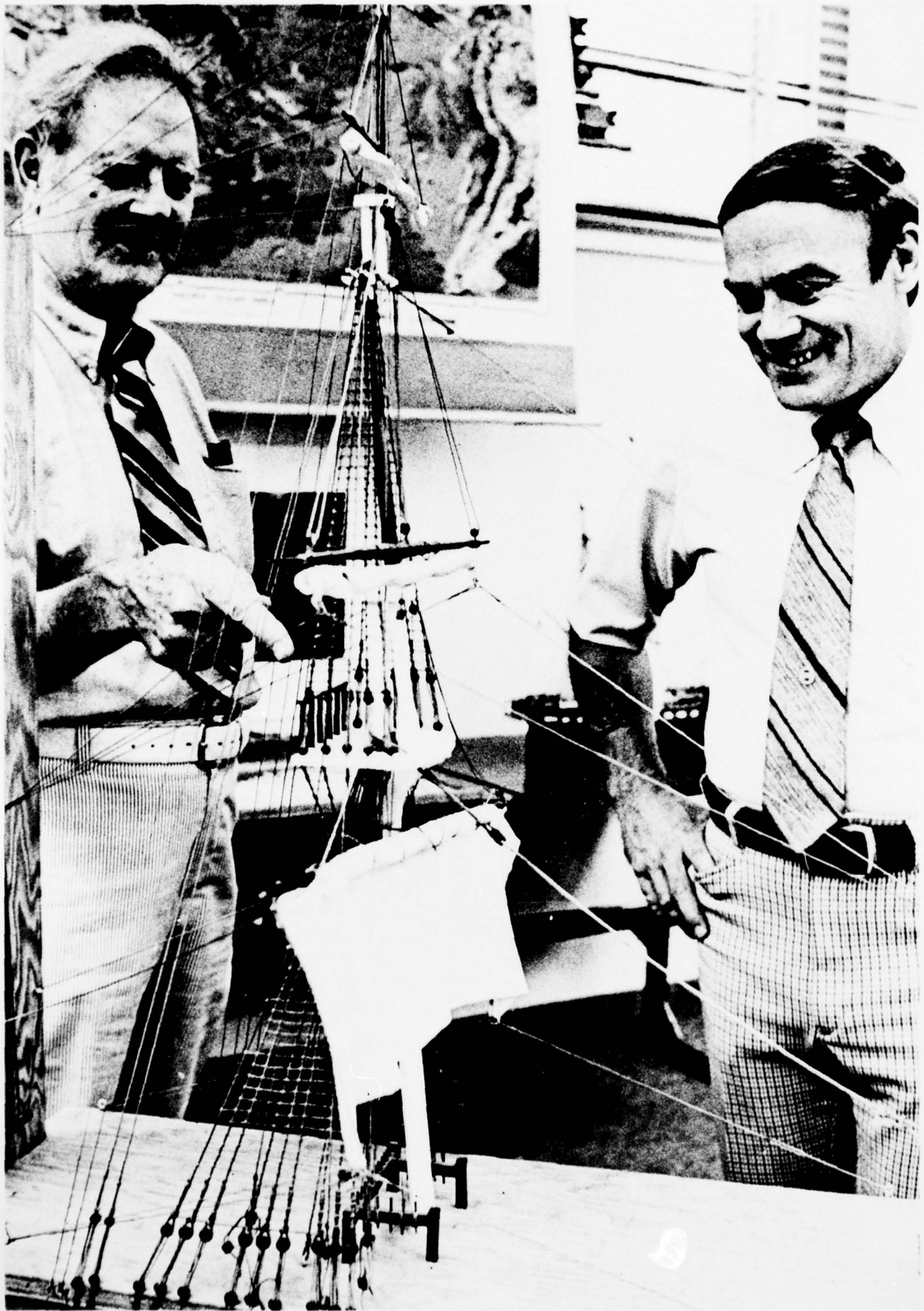
OLSEN, Charles F., Associate Professor, "Doppler Ultrasound: A Technique for Obtaining Arterial Wall Motion Parameters," IEEE Trans. Sonics and Ultrasonics, SU-24 (November 1977), 354-356.

A doppler ultrasound instrument was designed, custom built, and used to detect and provide information on arterial wall motion. Over a period of several months, a minimum of ten test-runs on seven individuals provided 755 sets of data for analysis. The error in the change in displacement from the mean of each individual was always less than 0.0022 cm. The range in displacement from this group of individuals was from 0.0120 cm to 0.0272 cm. Preliminary results indicated that the movement of the arterial wall relative to the ultrasonic transducer can be accurately determined and may be related to the state and patency and impulse-strength of the arterial pressure pulse which are presently determined by palpation.

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DIVISION OF  
ENGLISH AND HISTORY



## ENGLISH DEPARTMENT

*Professor Michael Jasperson, Chairman*

Academic Year 1977-1978 was an active and productive one for literary research and scholarly publication. Four sponsored projects were underway: the continuation of a study of the life and poetry of Robert Hayden; compilation of a comprehensive index of New York newspaper reviews of American authors, 1833-1860; a study of the real John Paul Jones and the legendary Jones of American lore and literature; and an investigation of the theory of narrative voice in fiction. Independent (non-funded) research, with eleven projects underway, included critical and bibliographical studies of American authors--Cotton Mather, Melville, Hemingway, Thomas Berger, and Faulkner--and studies in the English drama (Shakespeare and Chapman), English poetry (Chaucer and Samuel Johnson), and modern English fiction (E. M. Forster).

One book (an edition of new poems in traditional prosodies) was published, eight articles appeared in scholarly journals, and The Annual Bibliography of English Language and Literature (Volume 49) included contributions of a member of the English Department. Two papers were presented at meetings of professional societies.

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## NEW YORK CITY NEWSPAPER REVIEWS OF AMERICAN AUTHORS 1833-1860

Researcher: Assistant Professor Harriet F. Bergmann

Sponsor: Naval Academy Research Council

There exists no index to the extensive body of literary comment and criticism to be found in the newspapers of New York City between 1833 (the date of the establishment of the New York Sun) and 1860 (the onset of the Civil War). The careers of Herman Melville, Nathaniel Hawthorne, Edgar Allan Poe, Ralph Waldo Emerson, Margaret Fuller, Harriet Beecher Stowe, William Cullen Bryant, Henry David Thoreau, and Walt Whitman are included in this period, as are those of writers specifically connected with the Navy, such as George Bancroft, James Kirke Paulding, James Fenimore Cooper, and William Leggett. There exists an index to known reviews for only one of these authors, Herman Melville.

The purpose of this project, a phase in the preparation of a comprehensive index, is a careful study of New York newspapers from 1833 to 1840. Among the papers examined will be the Sun (established 1833), the Herald (1835), the Evening Post, the Commercial Advertiser, and the Merchant's Ledger.

The study, when completed, will provide a research tool to scholars of American history, American literature, and American culture, since the index will demonstrate the relationships between the nineteenth-century American press and the literature that is our heritage. Scholars of American literature and American culture will be able to see clearly the complex of political, personal, and professional alliances that determined the success or failure of an author in his or her own time.

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"MIDDLE PASSAGE": ROBERT HAYDEN'S ANTI-EPIC

Researcher: Assistant Professor Fred M. Fetrow

Sponsor: Naval Academy Research Council

Robert Hayden's "Middle Passage" is especially intriguing for its resistance to generic classification. Hayden himself remains rather ambivalent on this point. While his original plan seems explicit, he also claims a sort of mystic vision as the source of his ultimate format. However, another oblique authorial reference suggests an epic intention. And when one approaches the poem as a miniature epic, both generic mode and heightened meaning emerge. Hayden includes and yet inverts most of the traditional epic conventions and devices. This technique of ironic

inversion extends the moral implications of the ostensible subject, slave trade during the late seventeenth and early eighteenth centuries. More importantly, the technique embodies an epic structure which allows Hayden to enoble an epic "anti-hero" and to speak in a mythic voice in the creation of a folk epic which glorifies the real subjects of the poem, the Black victims of "Middle Passage."

This is a continuation of the investigation which was funded last year by the Naval Academy Research Council.

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#### JOHN PAUL JONES IN AMERICAN LITERATURE

Researcher: Assistant Professor Charles J. Nolan, Jr.

Sponsor: Naval Academy Research Council

Though historians have given extensive treatment to John Paul Jones, preliminary investigation indicates that no one has done significant research on the use of Jones in our imaginative literature. Because American authors have dealt with the Commodore in a surprising number of novels, dramas, and poems, the challenge is to discover why they so often chose him for their works and, more important, what their use of him means for American culture.

The basic methodology is simple. To set the record straight and to give the reader necessary background, Chapter One will provide a sketch of the historical John Paul Jones, of the man as he really was, at least to the degree that doing so is possible with such a colorful character. The second chapter, on the other hand, will tell a much different story. It will treat the legendary Jones--the figure who emerges from the chap-books, newspaper accounts, popular songs, and bits of doggerel. Chapters Three and Four, which will deal with the Jones who appears in fiction and in drama, will show how our imaginative writers, frequently influenced by legend, depict the Commodore. Finally, the fifth chapter will offer conclusions about what all this literary activity means for American culture--will explain, that is, why the figure of John Paul Jones maintains its hold on our national consciousness almost two hundred years after his death.

Historical and bibliographical research necessary for the writing of the first chapter is in progress.

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A THEORY OF NARRATIVE VOICE

Researcher: Assistant Professor Stephen M. Ross

Sponsor: Naval Academy Research Council

In recent years literary criticism has increasingly benefitted from theories and methods derived from disciplines such as linguistics, language philosophy, structural anthropology and psychology (the French Structuralists have been particularly influential). While this cross-circulation of ideas has offered the critic new tools for the analysis of works, it has also introduced into critical discourse terms and concepts badly in need of clarification. One such concept is "Voice." Common enough in ordinary usage, the word "Voice" has come to be applied in a specialized way to literature. "Voice" is used as a collective term for traditional concepts like "style," "tone," and "point of view." And just as a speaker's unique voice makes us aware of the person speaking, so "Voice" in a literary text allows us to sense the "person" behind the discourse: thus in some contexts "Voice" has been substituted for "character," "narrator," and even "author." The value of a concept of "Voice" in understanding literature has been recognized, and recent criticism shows a striking increase in its use. Unfortunately the concept's value has been dulled by imprecise usage. The project described here, by drawing on research in philosophy, the social sciences, and especially linguistics, seeks to provide a much needed definition of "voice" and its proper application to literary studies.

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DON DELILLO'S END-ZONE: PLAY AT THE BRINK

Researcher: Assistant Professor Neil Berman

This article-in-progress is a study of the tension between an essentially unplayful modern world and the spontaneous sports and games which partially redeem it. End Zone is at least superficially a book about football, but its title metaphor indicates that it is also a book about the decay of language and the ambiguous horror of nuclear war. There is nothing playful about the Logos College football season; instead, the only alternatives to the deadening influence of the "end zone" are spontaneous, primitive games which embody the characteristics of mature human play--joy, creativity, and freedom (see Huizinga, Fink, and Ehrmann). A snow football game, a highly ritualized "Bang You're Dead" game, and an unplanned, frenzied bout of verbal foreplay are the encroachments of play upon the grim possibility of purely reflexive, computerized, non-expressive language; a push-button holocaust; or Taft Robinson's monkish retreat into silence and geometry.

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THOMAS BERGER'S LITTLE BIG MAN

Researcher: Assistant Professor Neil Berman

Research shows that Berger has read and borrowed from standard works on the history of the Plains Indian Wars and Cheyenne culture. There are, for example, close paraphrases of sections of Black Elk Speaks and the work of George Bird Grinnell. Often materials from the Sioux culture are transformed to fit the Cheyenne; these loose borrowings in turn give an ironic complexity to Jack Crabb's Indian name, Little Big Man. Crabb becomes a combination of the Cheyenne hero Little Man and the Sioux agency policeman (and traitor) Little Big Man.

The narrative frame of the novel establishes a game in which historic details are manipulated to give an extravagantly panoramic view of western Americana. While many of the historic details are quite accurate, it is impossible to imagine that Jack Crabb could remember them so precisely. By contrast, there are many distortions of or shifts in both historical and cultural information. The reader must sift through this information to decide how Berger cum Snell cum Crabb intends the play with history to be taken. Since the very substance of Jack Crabb's character is that he is a trickster, a role player, it is not surprising that the narrative itself is a labyrinth whose puzzle must be solved.

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## DANTE'S PURGATORIAL MOUNT IN HEMINGWAY'S "SNOWS OF KILIMANJARO"

Researcher: Associate Professor John P. Boatman

Unlike previous investigators of Hemingway's most notable short story, who locate the source of the mountain symbolism in either a non-literary source, namely, the author's own first-hand knowledge and bitterly recollected misadventures in Tanganyika (Carlos Baker) or in a modern literary source, namely, a Flaubert letter, written in 1853, to "Madame X" (Louise Colet) where he speaks of the mountain of perfection in art, so difficult to scale, this researcher finds that:

(1) Hemingway leans heavily in his narration of Harry's "flight of the soul" upon parallels with the dream narrative in Canto IX of Dante's Purgatorio, where Dante the pilgrim in his sleep and dreaming is lifted up from the valley of death by God's eagle (as the imagined Compton lifts the dying Harry in his aircraft to the square top of Kilimanjaro) toward the east and sets him down on the mountain-side gate, there to begin his purgation proper (as Harry says, "to rub the fat off his soul").

(2) Hemingway reinforces his parallel by locating a "House of God" on top of Kilimanjaro, a fact that reflects Mosaic, Arabic, Hebrew, and Christian--especially Dantean--religious tradition that places the biblical Garden of Eden atop Kilimanjaro--one of several traditional sites--a choice reflected in Ariosto's Orlando Furioso as well as in many Portuguese travel accounts of the area, a tradition available to Hemingway in his known reading of Samuel White Baker's 1866 account of the long nineteenth-century search for the sources of the Nile.

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SHAKESPEARE'S HERALDIC "EPIPHANY" OF THE FUTURE KING IN HENRY IV, PART ONE

Researcher: Associate Professor John P. Boatman

In Act IV, sc iv, of Henry IV, Part One, Shakespeare constructs a tableau of three characters on the battlefield of Shrewsbury: Hal, the victor of the fight, upright between the dead Hotspur, his late enemy on one side and Falstaff, his late boon companion, now feigning death on the other. Most researchers read the tableau as either a representation of the Aristotelean "golden mean" (Hal) between the extremes of rashness (Hotspur) and cowardice (Falstaff) or as a depiction of the reformed prodigal (Hal) who has overcome the temptations of pride (Hotspur) and of the flesh (Falstaff). This investigator finds that the tableau serves a more fundamental purpose than heretofore suspected, a purpose dramatically evident to the contemporary audiences of the play.

This grouping of armed warriors makes its point through the heraldic devices carried on the shields of each knight in the tableau. Hotspur would display his family's device: the blue lion of Brabant (Louvain); Hal would display the royal arms of England--lions and fleurs-de-lis--(differenced by a label of three points since he is not yet king), and Falstaff would most likely display an antelope, a device in accord with the witty puns on Falstaff as a "fat deer," much given to nimble "running away" from sharp sword-play. If these are the arms displayed by the three knights of the tableau, then they constitute the future "achievement of arms" assigned to Hal as Henry V, of Agincourt fame, who bore the arms of England (undifferenced by a label) supported on the dexter base of his official coat of arms by a lion and on the sinister base by an antelope. Since this heraldic tableau occurs at the close of the first Henry IV play, but foreshadows the conclusion of the second, it argues that Shakespeare had both plays in mind before he concluded the first, an implication that denies that the second play was an afterthought designed to capitalize on the popularity of the first.

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DIDACTIC AND/OR TRAGIC: CHAPMAN'S STOIC HERO IN THE REVENGE OF BUSSY D'AMBOIS

Researcher: Assistant Professor Fred M. Fetrow

The standard interpretation of George Chapman's The Revenge of Bussy D'Ambois (1613) continues to sustain modern critical response. Modern critics, bound to the notion that Chapman's tragic hero is as self-sufficient as he is stoical, generally conclude that the play is didactically effective, "poetically successful but dramatically disappointing," largely because they discern no inner conflict in Clermont. However, re-examination of Clermont's characterization indicates that Chapman deliberately and carefully exhibits a tragic hero who continually struggles to accommodate belief and behavior. Thus Chapman does present a viable tragic hero, but Clermont comes to life not so much through his repeated demonstration of stoic principles, as in behavior which is contrary to his philosophy. So those critics of The Revenge who claim that Chapman sacrifices tragic effect for didacticism are simply mistaken, and the defenders of Chapman's dramatic skills are right, but for the wrong reasons.

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## HERMAN MELVILLE'S MAN-OF-WAR'S LIBRARY

Researcher: Professor Wilson L. Heflin

George E. Badger, Secretary of the United States Navy, endorsed on 19 May 1841 the proposal of the Board of Commissioners that "a cheap selection of books for the use of Seamen. . .is recommended," thus authorizing the first official libraries for enlisted men in United States

Navy ships. The expenditure for each library would be about \$100, and an official book list was chosen, consisting of 11 basic titles, bound volumes of the Penny Magazine, and selections from Harper's Family Library.

When the frigate United States was being outfitted for sea at Norfolk in late-1841, not all of the authorized titles were available. Purser George Loyall purchased from a Norfolk stationer, G. Hall, the following titles: Two Years Before the Mast, Robinson Crusoe, Various Narratives of Imprisonment, Shipwreck, Perils, and Captivity, The Naval Monument, Penny Magazine (9 bound volumes), and 117 volumes of Harper's Family Library. These books and magazines were available to Herman Melville during the 14 months he served as an ordinary seaman aboard the United States.

Two main problems of this investigation are: (1) Which of the 117 volumes of Harper's Family Library were sold to Purser Loyall by Stationer Hall? and (2) Was a portion of the Seamen's Library of the United States transferred to the frigate Savannah in July 1844, when Captain James Armstrong assumed temporary command of the Pacific Squadron of the United States Navy?

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#### COTTON MATHER: AN ESSAY IN BIBLIOGRAPHY

Researcher: Assistant Professor Charles J. Nolan, Jr.

Though Cotton Mather has long since been rescued from the Menckens, our conception of the man, his works, and his literary influence has undergone continual redefinition. Hence, this article examines the major books and articles dealing with Mather that have been published since his lifetime. Included in the survey are bibliographies, editions, manuscripts, letters, biographies, and critical studies, the latter two categories occupying the major portion of the essay because of their obvious importance for assessing Mather's place in literary history. In general, scholars are split in their view of Mather the man. Some have seen him as narrow and pedantic; others, especially in the twentieth century, as misunderstood and brilliant. No doubt, a sympathetic assessment will finally prevail. Mather criticism, of course, has suffered from a similar bifurcation, though appreciative studies have been and will continue to be most plentiful. Some of the major works, certainly the Magnalia, have received extensive analysis, and more, clearly, will come; of the 450 books comprising Mather's canon, only a few have been exhaustively treated. Hence, much yet remains to be done, especially the tasks of editing various texts, of explicating minor works, and of providing a clearer focus still of Mather's influence on the nineteenth century.

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## STRUCTURAL SOPHISTICATION IN "THE COMPLAINT UNTO PITY"

Researcher: Assistant Professor Charles J. Nolan, Jr.

Critics have often regarded "The Complaint unto Pity" as just an early poem in which Chaucer makes use of a standard form. But perhaps the best way to read the poem is to see it as a rather sophisticated if problematic attempt to blend the amorous and the legal complaints and to note some of the advantageous effects that such a mixture has upon representative aspects of the poem. There can be no doubt that the piece is a standard lover's plea because all of the elements of that form manifest themselves in the work. What has not been generally recognized is that Chaucer also employs the structure of the legal bill in the second half of the poem, a structure consisting of an address, a statement of grievance, and a prayer for remedy. Such recognition resolves several of the problems that critics have raised and also makes clear the advantages that Chaucer gains from the merger of the two complaint forms, particularly an intensified language and an enriched personification. Thus "The Complaint unto Pity" demonstrates Chaucer's already highly developed skill and foreshadows the kind of technical brilliance he will later so fully display.

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## CLASSICAL DECORUM IN JOHNSON'S EPITAPH ON HANMER

Researcher: Assistant Professor Pamela W. Roblyer

The purpose of this essay is to examine Johnson's epitaph on Sir Thomas Hanmer and to demonstrate the importance to its composition of the classical concept of decorum--the idea that the poet's subject and occasion are enhanced by the proper selection of genre and rhetoric. According to classical rhetoricians, the epideictic (or demonstrative) oration is the proper genre to be used if a noble or virtuous man is the subject and his death the occasion, for it is specifically designed to provide the poet with a structure--an exordium, divisio, and conclusio--and the appropriate topics by which he can effectively praise the particular virtues of the deceased. The prescribed topics to be used are the subject's external circumstances, his physical advantages, and his virtues of character.

An examination of the poem reveals that Johnson was following the precepts of classical rhetoric in writing his epitaph on Hanmer. Not only does he take up the prescribed topics of the epideictic oration, but he uses an elevated style--balance, repetition, and parallelism--that is appropriate for his noble subject.

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FAULKNER'S ABSALOM, ABSALOM! AND THE DAVID STORY

Researcher: Assistant Professor Stephen M. Ross

William Faulkner valued the Old Testament for its stories and characters more than for its philosophy. In exploring how the David Story comes to be renewed in Absalom, Absalom!, we must examine the ways in which Faulkner rearranges the story and the relationships among characters; we need not be concerned with his acceptance or rejection of ideas embodied in the David Myth. The novel's main character, Thomas Sutpen, should be seen as more than a morally inadequate "David figure," but also as a "king" and "father" figure in a more general sense. Like David, Sutpen succeeds in the terms demanded by his culture, and like David he has qualities of boyishness and naivete which separate him from the other cotton barons of the South. But Sutpen is like Saul, too, in his superior stature and prowess, and more importantly in his attempt to use his own son to prevent another son's rightful inheritance. Faulkner also makes use of the relationships between Saul-Jonathan-David, and between David-Amnon-Absalom in setting up the Sutpen-Charles-Henry triad: we are given a third version of the Father-Son-Brother structure, a version that draws as heavily on Jonathan's love for David (in I Samuel) as on the oft-noted Amnon-Absalom feud in II Samuel. Each of these familial struggles grows out of the conflicting demands of love and authority. A fourth version of this triad, in fact, can be seen in the Mr. Compson-Shreve-Quentin triad, which recuperates the implications of the David myth on a hermeneutic level. Quentin (as John Irwin has shown) is engaged in a struggle with his own double, his internal "darker brother." In Absalom, Absalom! this struggle is waged in the act of interpreting truth: as Quentin hears and rehearses the "truth" of the Sutpen saga, he is forced to confront the same disparity between love and authority that marks the David story.

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RHETORICAL DEVIATIONS IN FORSTER'S MAURICE

Researcher: Assistant Professor Molly B. Tinsley

The general purpose of this study is to demonstrate the continuity between structure in a novel and the texture of its prose. More specifically, the researcher intends to show how certain syntactical choices in E. M. Forster's novel Maurice come to reflect issues of tone and theme. The ground style of Maurice is characterized by the breach of rhetorical conventions suggestive of its hero's deviation from sexual conventions. Forster's style also relies heavily on multiple predicate constructions which image the hero's awkward but persistent energy. Manual counts of these style elements are introduced to support qualitative analysis of their thematic function.

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HILL, John M., Assistant Professor, "Blameless Passion in Desperate Remedies and Hardy's Minor Fiction: Sensations of the Uncanny," Recovering Literature, 6 (Spring 1977), 5-26.

In each of his major novels Hardy usually depicts a passionate character who either ends tragically or accepts a painfully reduced existence--the Bathshebas, Tesses, and Judes of his fiction. Their passions conflict either with their moral natures or with a greater morality somehow at work in the fiction. Only amoral or immoral characters can be passionate and not punished--the villains and seducers, usually male, in Hardy's novels. And even they are either relegated in the end to inconsequence or simply dismissed. But occasionally in his minor fiction Hardy depicts essentially moral characters given to intense passion. These figures are not then punished or reduced in their existence. Their passions, including clear sexual jealousy, are punishment enough. Because they are possessed by their passions, as though by some uncanny force, they are blameless (not responsible for their desires).

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HILL, John M., Assistant Professor, "Corpuscular Fundament: Swift and the Mechanical Philosophy," Enlightenment Essays, 5 (Spring 1975), 36-48 (published Spring 1977).

Swift, England's greatest satirist, has only unkind things to say about the mechanical science of his day. But far from reacting merely as a conservative, he is perceptive at a high level about the principles and assumptions of the new mechanical philosophers (Newton, Boyle, Descartes, Gassendi and others). He does not merely attack scientific zeal or excessiveness in research. He focuses in Book III of Gulliver's Travels on both mathematical theoreticians and empirical experimenters, hitting them for their primary assumptions, their logic, their convalidated metaphors, their heuristic schemes and their lack of common sense. By means of brilliant reductio ad absurdum sketches, Swift asserts the inadequacy and pretentiousness of the mechanical philosophy. To a surprising extent he is accurate in his appraisals.

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HILL, John M., Assistant Professor, "The Good Fields of Grief: Remnants of Christian Conversion in Three Anglo-Saxon Poems," Psychocultural Review, 2 (Winter 1978), 27-43.

The rapid conversion of pagan Anglo-Saxon kingdoms to Christianity has been ascribed generally to a clever politics of accommodation, set in motion by Pope Gregory. Yet much of Anglo-Saxon poetry testifies to a

more powerful tactic: psychological manipulations that transform secular behaviors and ideals into Christian ones. In three of the best Anglo-Saxon poems, "The Wanderer," "The Dream of the Rood," and "The Battle of Maldon," the psychology of mourning is powerfully manipulated. By intercepting the mourning process just short of "normal" resolution, the Church seems to have found a way of radically altering secular behavior, with the result that a new relationship comes into being between the lord and his retainer and between the exile and his consolation. In both cases, earthly losses are only overcome through a transcendental consolation, the hope of which transforms exiles into wise men and apostles and promises transcendental glory for the otherwise suicidal retainer.

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JASON, Philip K., Associate Professor, "Doubles / Don Juans: Anais Nin and Otto Rank," Mosaic: A Journal for the Comparative Study of Literature and Ideas, 11 (Winter 1978), 81-94.

The influence of Otto Rank's works and personality on the writings of Anais Nin can be traced through episodes recorded in Nin's Diaries and through a comparison of Rank's critical pronouncements with those fictions written by Nin soon after the beginning of her association with this major figure in psychoanalysis. Specifically, Rank's explanations of the motifs of the "Double" and the "Don Juan," first made available to Nin in a 1932 French edition of Rank's work, and elaborated in discussions between them, inform Nin's prose poem "House of Incest"; her stories "Winter of Artifice," "The Voice," and "Stella"; and her novel A Spy in the House of Love. Nin's relationship with Rank, first as patient and later as assistant, was influential in an additional way. The character called "the voice" in the story by that name and the device called the "lie detector" in A Spy in the House of Love are drawn, in part, from impressions and descriptions of Rank first recorded in Nin's Diaries.

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JASON, Philip K., Associate Professor, editor, Shaping: New Poems in Traditional Prosodies. Washington, D. C.: Dryad Press, 1978.

We are now witnessing a reaction against decades of poetry that has tried to do more with less: less sonic density, less rhythmic backbone, less line integrity--less of almost all of those conventions by which poetry had distinguished itself from other literary genres. This reaction, a renewed concern for the physical nature of language, is represented by the forty-two poems in Shaping. The collection is a quality anthology of contemporary poetry: our idioms, our concerns, our sense of life. It is also a demonstration that contemporaneity and continuity of tradition are not mutually exclusive compartments of mind or art. In the poem,

they can and do meet as one. The book includes a brief introduction and an analytic index.

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JASON Philip K., Associate Professor, "Stanzas and Anti-Stanzas," College English, 39 (February 1978), 738-744.

An examination of representative stanzaic poems by Wordsworth, Hardy, and William Heyen suggests that the conventions of the stanza include an explicit or implicit norm against which functional variations may be made. The stanzaic unit is defined as a discrete stage in the intellectual, emotional, rhetorical, or imagistic process of a given poem. The practice, in modern and contemporary poetry, of casting essentially non-stanzaic works in stanzaic shapes is challenged. The author, using as illustration poems by Sylvia Plath and James Tate, considers the stanzaic appearance of such poems as misguided, if not deceitful. The practice of borrowing the prestige of stanzaic form without paying the price of stanzaic control calls contemporary poetics into question and threatens to obscure the achievements of those who have written or continue to write effective, controlled stanzaic poetry.

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LEFCOWITZ, Allan B., Professor, co-editor, "James Bryce's First Visit to America: The New England Section of His 1870 Journal and Related Correspondence," New England Quarterly, 50 (June 1977), 314-331.

When the 32-year-old Englishman James Bryce made his first visit to the United States in 1870, he kept a journal of his observations, now in the Bodleian Library. The young man who was to write The American Commonwealth eighteen years later had a sharp eye for detail, and his observations, set down in a 5 inch by 8 inch hardback notebook, are unusually insightful--concerning the American landscape and American customs, educational and political systems, American men of letters and American men of affairs. Especially interesting are his visits with Ralph Waldo Emerson, Oliver Wendell Holmes the Elder, and James Russell Lowell, his trip to Harvard College, and his experiences in American railroad cars and stagecoaches. This article presents a careful transcript of the New England portion of Bryce's 1870 journal and provides informative notes concerning the persons mentioned therein.

This article also includes a letter from Bryce to his sister Kate (18 October 1870) in which he describes a visit to Naushon Island (owned entirely by one man, John Murray Forbes) and an exciting, though unsuccessful, deer hunt there.

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NOLAN, Charles J., Jr., Assistant Professor, Contributions to the Annual Bibliography of English Language and Literature, Volume 49, eds. Derek Roper, James B. Misenheimer, Jr., and Mary Jean DeMarr. Leeds: Modern Humanities Research Association, 1977.

Contributions to the Annual Bibliography come from a careful review of the many issues of sixteen journals ranging from Anthropological Linguistics to the International Philosophical Quarterly. The contributor examines and notes any article, edition, book, or thesis, published in any language, that has an important link to English or American language or literature and any ancillary work that bears significantly on those fields. Using a specialized format, he then prepares bibliography cards for such items and forwards them to the American editor, who in turn sends the American contribution to Leeds, England, where the Annual Bibliography is published. The result each year is one of the two major bibliographies in English studies.

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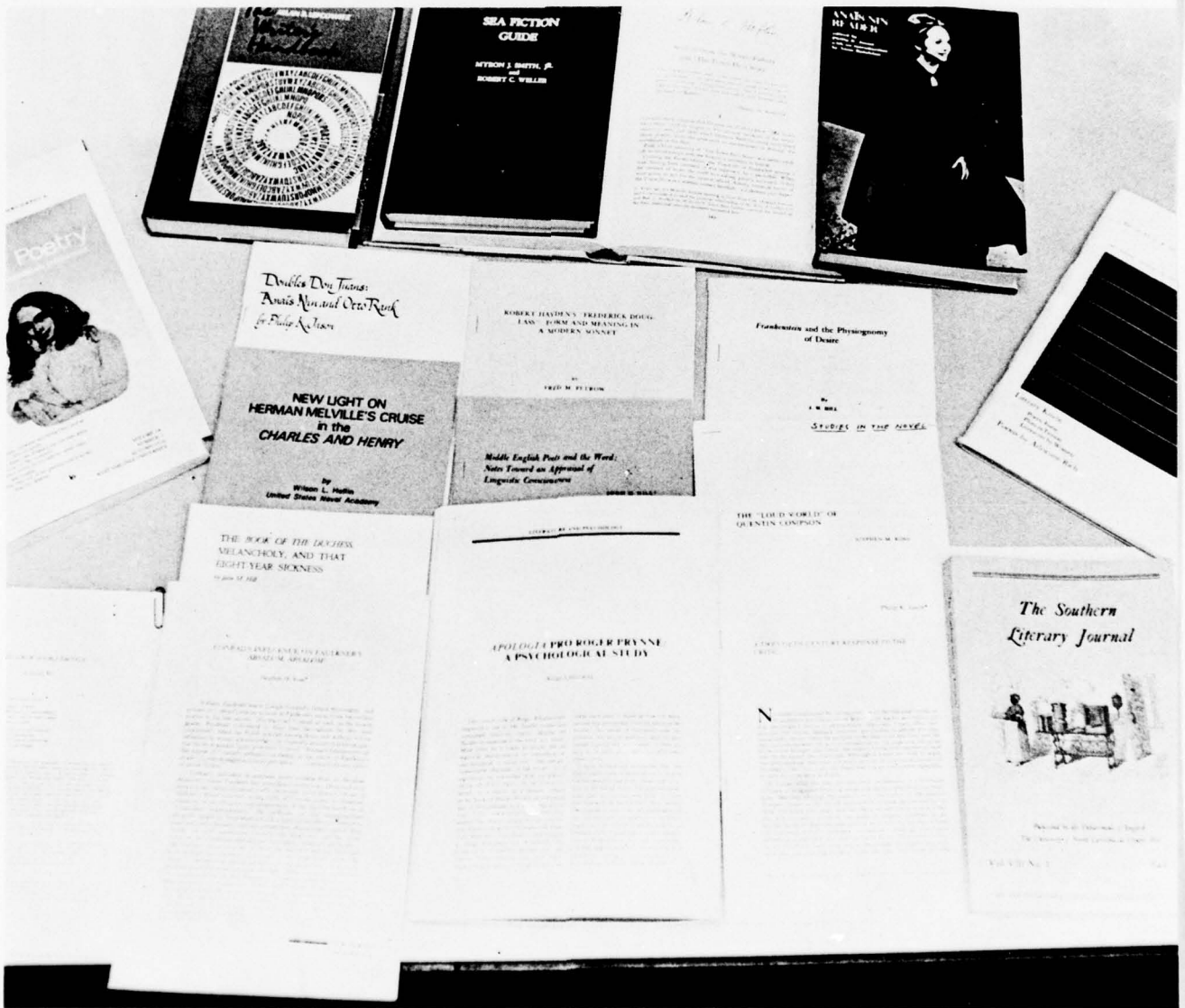
NOLAN, Charles J., Jr., Assistant Professor, "The Rhetorical End: 'Venus at St. Anne's,'" The Bulletin of the New York C. S. Lewis Society, 9, No. 1 (1977), 8-9.

In advancing his Christian theme in That Hideous Strength, C. S. Lewis carefully structures the novel to persuade his readers that what he has to say is of vital importance. The final chapter in particular--"Venus at St. Anne's"--is rhetorically satisfying because it knits together the various motifs he has used throughout the book. In Section One, Lewis depicts the penultimate stages of Mark's growth to maturity. Section Two, on the other hand, highlights the fertility motif which has variously manifested itself throughout the novel. The third part of the chapter seems especially designed to satisfy reader expectations as well as to fulfill other rhetorical purposes. But Section Four is perhaps more important because in the discussion of Logres and Britain the author is able to clarify the frequent Arthurian allusions and by so doing to suggest the reason for the book's many polarities. Grace Ironwood's comment near the end of this part of the chapter--"nearly everyone except the very good . . . and the very bad had already left Edgestow" before the earthquake--is dramatized in the next section by the ironic portrayal of Curry. But Section Six is the heart of the chapter as the order of love is reestablished "to make Earth sane." This theme of love is most fully resolved, however, in the chapter's final two parts.

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PITT, A. Stuart, Professor, "'Last Scene of All'" The Author of Miriam Coffin in the Canary Islands," Historic Nantucket, 25 (Fall 1977), 9-13.

This article presents newly researched materials from the letters and dispatches of U. S. Consuls in the National Archives as a contribution to a fuller knowledge of the biography and literary career of Joseph Coleman Hart (1798-1855), author of the whaling novel Miriam Coffin, an important precursor of Melville's Moby-Dick. Hitherto uncollected details of his career as teacher, compiler of school atlases, geographies, and geographical exercises, and U. S. Consul at Santa Cruz on Teneriffe in the Canary Islands are associated with his interest in Nantucket and the whaling industry as materials for romance.



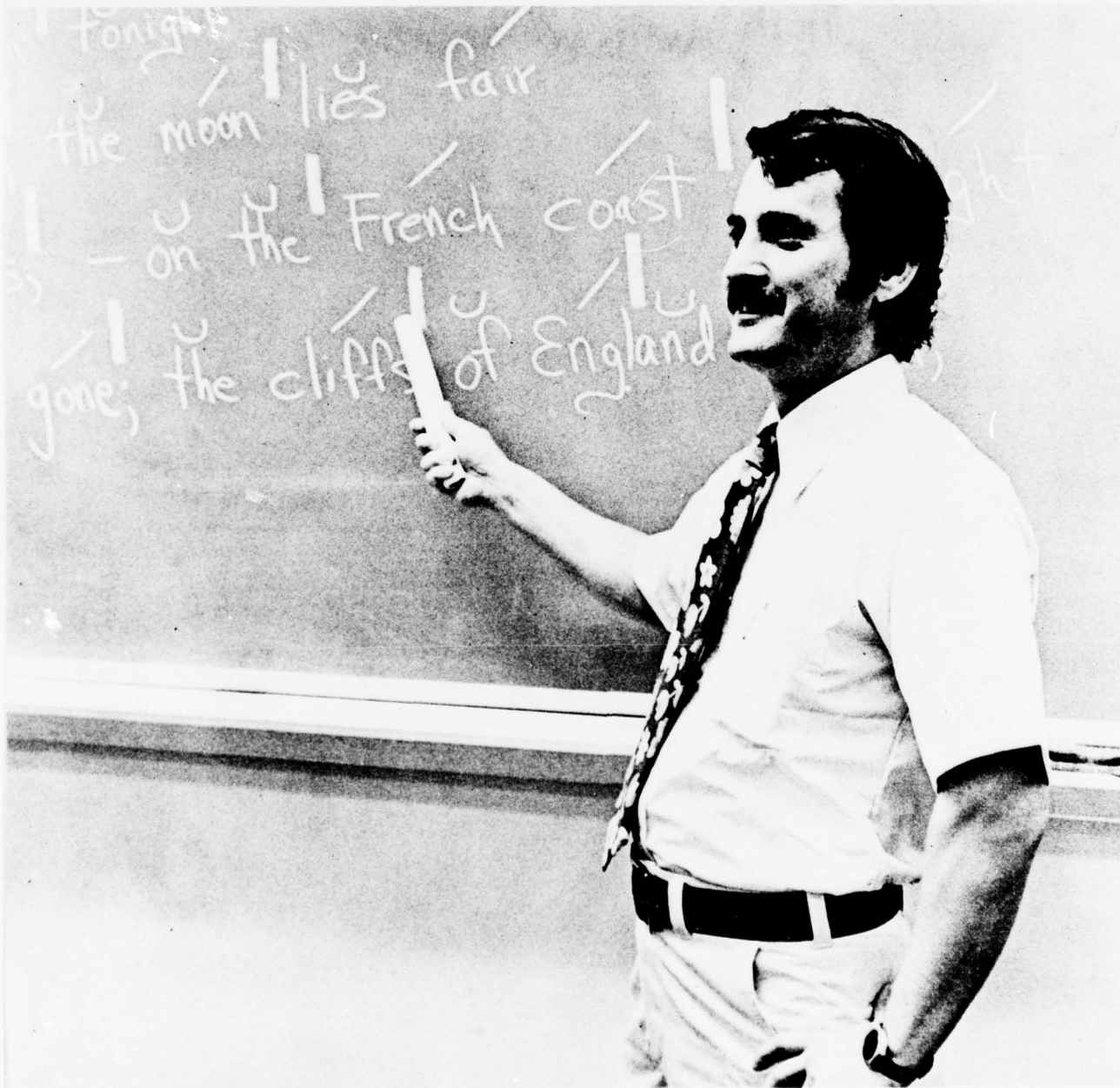
PRESENTATIONS

ENGLISH DEPARTMENT

NOLAN, Charles J., Jr., Assistant Professor, "Thy Mysterious Aaron Burr,"  
USNA History Club, United States Naval Academy, 21 November 1977.

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ROSS, Stephen M., co-author, "The Empty Locus of Desire: Visions and  
Revisions of the Family in Modern American Fiction," Annual Meeting  
of the Modern Language Association, Chicago, Illinois, December 1977



## HISTORY DEPARTMENT

*Professor Larry V. Thompson, Chairman*

The History Department experienced another successful year of research and publication in 1977-1978. Two books were published, both of which dealt with naval history topics. Department members also edited or co-authored two other works concerned with diplomatic and naval history. Additionally, essays and chapters appeared in four anthologies, while a total of eight scholarly articles were published. Furthermore, a Trident Scholar Project, undertaken by a history major and directed by a staff member, reached a highly successful conclusion and is currently being revised for submission as a scholarly article. Further scholarly products are anticipated, as faculty members presently have six manuscripts in-press, with publication expected next year.

The History Department faculty continues to be active in participation at scholarly conferences held throughout the country. Staff members served as chairmen or commentators for six programs during the year and delivered eight presentations to various professional groups. Moreover, the Department hosted a Naval History Symposium in October 1977, attended by over four hundred scholars from around the world. The symposium papers are currently being edited within the Department for book publication in 1979.

Four Naval Academy Research Council grants were awarded to the Department this academic year. Faculty recipients will pursue research projects as diverse as editing the Papers of John Paul Jones, preparing a monograph on Carolingian Military Strategy, examining the Weltanschauung and disciplinary perceptions of representative turn-of-the-century humanists, and investigating the climate and causation surrounding the ethnic riots in Los Angeles in 1943. These projects, when added to the sponsored and independent research efforts currently underway, ensure that abundant historical scholarship will be forthcoming in the near future.

In sum, the History Department is heavily involved in research which is reflected in the enrichment of the classroom experience as well as in considerable numbers of scholarly publications and professional papers.

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## THE "TWO CULTURES": TOWARDS AN INSTITUTIONAL ANALYSIS OF THE PERIOD 1880-1930

Researcher: Assistant Professor P. Robert Artigiani

Sponsor: Naval Academy Research Council

In the Rede Lecture of 1959, C. P. Snow characterized contemporary society as polarized between scientists and humanists. Although his argument led to a great deal of agitated discussion at the time, little real scholarly research has been focused on the issue he raised. Consequently, although the evidence for the existence of "Two Culture" is overwhelming, not much is known about the reasons scientists and humanists have defined themselves and one another in mutually antagonistic ways.

The absence of scholarship is particularly unfortunate in the case of historians of science, whose reason for being, according to George Sarton, is to bridge the gap between science and the humanities. This failure can be assumed to have resulted from the breadth and amorphousness of the material involved.

The social science techniques pioneered by Max Weber, R. K. Merton, Joseph Ben-David, and others for the study of "science as an institution" can help deal with this problem. These techniques offer a concise method for the organization of material into manageable forms. Although logically and empirically sophisticated, they are ahistorical in nature and must be applied subtly. Modified somewhat by Kuhn's concept of "scientific paradigms," these same techniques can be used to produce institutional studies of specific elements within the "humanists culture."

Essentially, this study isolates a representative body of professionals and analyzes the ways in which they defined themselves and their disciplines. Particular emphasis is placed on the kinds of work the selected individuals did, the reasons they gave for admiring the work of others, the methods by which their work was carried out, the advice they gave to younger contemporaries, and the philosophical statements they made about their work. To measure the institutional consensus behind the statements made by the selected individuals, recourse must frequently be made to the award ceremonies, obituary notices, and public discussions of various professional corporations and bodies.

The proposed research will be confined to the 1880-1930 period because these fifty years witnessed revolutionary changes in the dominant paradigms of both base groups. Because this work has already been done for the scientific community during the period in question, the proposed research will concentrate on humanists. In the interests of clarity and simplification, however, efforts will be limited to artists and poets. This reduction is less arbitrary than it may seem, since painters and poets represent, respectively, the most advanced and the most articulate creative personalities in the humanist camp.

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THE PAPERS OF JOHN PAUL JONES

Researcher: Assistant Professor James C. Bradford

Sponsor: Naval Academy Research Council and National Historical  
Publications and Records Commission

This project will produce a complete, scholarly edition of the writings of John Paul Jones, America's foremost naval hero. The first step (currently underway) is the collection of Jones' materials. Copies of materials in the National Archives, Library of Congress, and the Naval Academy Museum will be collected first and contacts made with the one hundred other institutions possessing Jones' materials. Upon arrival the papers will be accessioned and filed, and target cards will be prepared for future photographing. Later documents will be prepared for reproduction in microform and a finding-guide will be produced. Lastly, the documents to be included in the letterpress edition will be selected, typescripts prepared, and annotations compiled. The end-products will be a highly selective letterpress single volume; a four- or five-reel microfilm or a microfiche edition of all of Jones' papers; and a finding-guide to those materials.

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DYNAMIC GRAPHIC MILITARY ENGAGEMENTS THROUGH COMPUTER SUPPORT

Researcher: Associate Professor William M. Darden

Sponsor: Naval Academy (Academic Dean)

There are three objectives in the development of Dynamic Graphic Military Engagements: (1) to present in a dynamic way, military and naval campaigns and battles; (2) to be able to show the possible outcome in a graphic way if the situation changes; and (3) to cause the student to make a sound decision "while under fire."

These objectives will be achieved by the use of interactive computer-simulation of naval and land warfare to offer any prospective officer a practical foundation for facing professional problems--problems that may involve national policy, military organization, strategic decision, logistics, tactics, command relationship, or leadership. Two basic concepts will be emphasized: (1) the influence of technological, economic, social, and political change upon evolving military and naval policy and operations; and (2) the constant factors which persist throughout naval and military history, and promise to remain constant despite dramatic changes in technology or social order throughout the world.

This program allows the student to take the place of any commander and fight the battle as it was fought or to make changes in strategic and tactical situations and see what would have been.

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THE NORSE IMPACT UPON MILITARY STRATEGY IN WEST FRANCIA, 862-869

Researcher: Assistant Professor Carroll M. Gillmor

Sponsor: Naval Academy Research Council

Until the Northmen first attacked the seacoasts and later directed their raids inland from island naval bases situated in the rivers, the strategy of Carolingian monarchs (Charlemagne and his successors) had been oriented towards offensive wars of conquest on land. This study will show how Charles the Bald, a grandson of Charlemagne, devised a strategy to deal with these searaiders, and in so doing, brought about a shift from offensive to defensive strategy--first in the Seine basin after 862, and then in the Loire region in 869. By examining the response of a land-oriented military force to invasion by searaiders, this study will make a significant contribution to the early history of European seapower.

Research has revealed that the signposts of an increasing reliance on defense strategy were indicated by three events. In 862, after unsuccessful defensive military operations against the Northmen, the king first stumbled upon the potential of fortified bridges to halt the advance of the Northmen on the principal rivers of the realm. Although rampart construction began at Pitres on the Seine in 862, the extension of Charles's defense measures into the Loire basin was not undertaken until 869, in the aftermath of frontier commander Robert the Strong in 866 and the beginning of stronghold construction in the Loire basin in 869. While Charles's defense efforts were being directed toward a building project in the Seine basin, Robert the Strong took the offensive against the Northmen of the Loire region. Until 866, these two spheres of action were implemented in geographical isolation. Only after Robert was killed and the campaigns of his successor had proven ineffective, did the king begin a defense strategy with the erection of strongholds for the protection of the Loire area. This study will also analyze the king's problem of maintaining garrisons in these new fortifications, especially since the existing military organization did not have the machinery to maintain forces throughout the year, but was designed to mobilize armies on an ad hoc basis for offensive campaigns.

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NATIVISM, ETHNICITY, AND THE ENLISTED FORCE OF THE NAVY AND MARINE CORPS,  
1870-1910

Researcher: Assistant Professor Frederick S. Harrod

Sponsor: Naval Academy Research Council

During the late nineteenth century, growing nativist sentiment throughout the nation had its counterpart in efforts to "Americanize" the enlisted force. Although the Navy had traditionally accepted large numbers of foreigners, it became increasingly displeased with what Secretary Benjamin Tracy characterized as its "mongrel crews." In Manning the New Navy, the researcher considered some aspects of this subject, yet many important avenues of research relating to the attitudes of navy officials and civilians toward foreigners in the service remain to be explored. In addition, the Marine Corps is completely unstudied.

The project is continuing along three main lines of research. One avenue is additional searching for writings by nativists on the Navy and Marine Corps and writings by officers expressing nativist sentiments to establish personal and ideological links between the two groups. The second area of concentration is further archival research into Navy and Marine policies regarding aliens. The third major line of study concerns the enlisted force of the Marine Corps. There is a need to investigate all aspects of Marine enlisted policy as well as particular questions relating to non-citizens in the force. In this way it will be possible to understand the specific policies of the Marines and to compare these policies to those of the Navy.



THE IDENTITY OF MIND AND BRAIN

Researcher: Associate Professor David E. Johnson

Sponsor: Naval Academy (Sabbatical Leave)

The purpose of this research is to probe a pressing intellectual problem that has the potential of becoming a "Copernican revolution" in the 20th century. The research is concerned with the question of whether the traditional dualistic model of man (body and mind or soul) can be defended in the face of research in philosophy, biology, psychology, and computers. The investigation involves reviewing the latest findings in two separate areas: (1) conceptual distinctions and arguments, found mainly in (analytical) philosophy; and (2) empirical arguments derived from research into what can causally explain so-called mental phenomena. Although this project is very complex in itself, there are far-reaching ethical and religious implications of possible conclusions that might be reached on the identity of the mind and the brain. The ethical and religious issues will be investigated further after some clarity on the present research is achieved.

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NAVAL SOCIAL RESPONSIBILITIES IN LOS ANGELES RIOTS OF 1943: A NEW PERSPECTIVE

Researcher: Lieutenant Don T. Sine, USN

Sponsor: Naval Academy Research Council

In June 1943, a riot took place in the city of Los Angeles, California, between boys of Mexican-American heritage and sailors of the United States Navy. Although the riot only lasted during six days and nights, the seeds of discontent had been growing over two years, and the ramifications of the riots were felt not only in California, but also in Washington, D. C., Mexico, Germany, and Japan. Various investigations took place to determine if the riots were backed by the Communists, or a Fifth Column element, or dissidents in this country, and if they were aimed at upsetting the war effort. Research will be directed at determining the validity of the accusations that foreign agents and/or domestic dissidents were the catalyst for the riots.

Research is being conducted at the University of California, Los Angeles, the Federal Archives in Laguna Niguel, California, and at the Huntington Library in California.

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NAVAL PRESENCE AND COLD WAR FOREIGN POLICY: A STUDY OF THE DECISION TO  
STATION THE SIXTH FLEET IN THE MEDITERRANEAN, 1945-1948

Researcher: Midshipman 1/C Dennis M. Pricolo

Adviser: Assistant Professor Robert W. Love, Jr.

Sponsor: Trident Scholar Program

This project concerned the American Navy's decision in the early years of the Cold War to pre-position naval forces in the Mediterranean in support of American foreign policy in that theatre. It is the first study of this specific topic within the general context of postwar strategic war-planning. Research for the study was primarily archival, and included a number of recently declassified collections such as JCS MSS 1945-1948 (National Archives), and CNO MSS, Leahy MSS, Nimitz MSS, and War Planning Files, (Operational Archives, Naval History Division, Washington, D. C.).

The project demonstrated that the Navy's decision to pre-position carrier task-forces in the Mediterranean was closely linked to War Plan PINCHER, the major American strategic plan for a war between the United States and the Soviet Union. In such a conflict, the United States would have relied on British military assistance to hold a line of communications from the English Channel through Gibraltar to Suez against an overpowering Soviet ground and air offensive on the Continent. Since British forces relied on oil imported from the Middle East--and since American industrial mobilization also depended marginally on the same source--Navy strategists believed that protection of Turkish sovereignty was a vital step toward denying the Soviets an advanced position from which they could someday attack the oil fields of the Middle East. To counter Soviet pressures on both Turkey and Greece, whose seizure by leftist insurgents would outflank the Turkish position, the Navy carefully undertook several demonstrations in 1946 to signal American interest in the regimes in Athens and Ankara. The success of these demonstrations was capped in the fall of 1946 by the Navy's decision to maintain a carrier task force permanently in the theatre. In turn, this strategy, plus the completion of War Plan PINCHER, provided the strategic justification for the political decision in early 1947 to pledge United States Government resources to the defense against Russian invasion or subversion of both nations.

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TITANS IN TRIUMPH--THE U. S. NAVY'S CARRIERS IN WESTERN PACIFIC WATERS,  
OCTOBER 1944-JANUARY 1945

Researcher: Professor William M. Belote

The objective of this project is to present a balanced, chronological account of book-length of the history of U. S. Navy carrier operations from October 1944 to the end of January 1945. The narrative will consist of approximately 50,000 words and will include some 50 illustrations selected by the authors. Recurrent themes to be treated will include the progressive improvement of carrier operating techniques, the resolution of psychological and other problems arising from prolonged war zone operations, and the special crisis induced by the Japanese decision to use "special attack" (Kamikaze) techniques against the Navy's fast carrier forces. Eight chapters of a projected ten are complete as initial draft copy.

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NAVAL DEVELOPMENTS IN THE LATE NINETEENTH CENTURY

Researcher: Assistant Professor James C. Bradford

This study traces the post-Civil War decline and rebirth of the United States Navy. Emphasis is placed on the Navy's roles in American defense policy and its part in the nation's commercial expansion during the era. Technological developments are examined in the context of world-wide developments in the field. A final theme will be the rise of institutionalized professionalism within the naval service, including a discussion of the establishment of the Naval War College, the founding of the Naval Institute, and the beginnings of the Office of Naval Intelligence.

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RESCUING THE CONVENTION ARMY, DECEMBER 1778: AN OVERLOOKED FEATURE OF THE  
AMERICAN REVOLUTION

Researcher: Professor William L. Calderhead

The surrender of Burgoyne's army at Saratoga is a well-known feature of the American Revolution. Less well known is the fact that a serious effort was made to recapture that force which had come to be called "the Convention Army."

It will be the purpose of this investigation to describe the activities of the British Army and Navy in New York to launch secretly a major amphibious effort to rescue this force of British captives as it marched south to its final internment camp in Virginia. The effort ended in

failure, but since the Americans were never certain that the operation was a rescue mission, and since General Clinton chose to cover it up in his official report to the King (chiefly because it had not succeeded), historians on both sides have either neglected it or have discounted its existence. All of the research has been completed.

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#### BIOGRAPHY OF REAR ADMIRAL FRENCH ENSOR CHADWICK, 1844-1919

Researcher: Professor Paolo E. Coletta

This biography traces the reasons Chadwick applied for admission to the Naval Academy and his training at the Academy while it was at Newport during the Civil War. It also details his service on numerous ships, as a teacher of mathematics at USNA, 1872-1875, as the first naval attache (to London, 1882-1889), and as commanding officer of the Yorktown in the Squadron of Evolution (1889-1891). Chadwick also served as Chief of the Office of Naval Intelligence, 1892-93; Chief of the Bureau of Equipment, 1893-1897; Commanding Officer of the cruiser New York and Chief of Staff to Rear Admiral William Sampson during the Spanish American War; President of the Naval War College and member of the General Board, 1900-1903; and Commander South Atlantic Squadron 1904 until his retirement in 1906. He then wrote four volumes of naval and diplomatic history, a book on the causes of the Civil War, and numerous articles. Research and writing were completed in 1978.

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#### THE CHIEFS OF NAVAL OPERATIONS: REAR ADMIRAL LOUIS E. DENFELD

Researcher: Professor Paolo E. Coletta

Rear Admiral Louis E. Denfeld served in battleships, destroyers, and submarines, but his specialty was personnel administration. After serving as commander of a battleship division that supported the Okinawa campaign, and as Chief of the Bureau of Naval Personnel, he assumed command of the Pacific Fleet on 28 February 1947. He was selected as Chief of Naval Operations on 15 December 1947, and quickly was frustrated not only by the rapid postwar demobilization but by problems with the unification of the armed forces that occurred as a consequence of the National Security Act of 26 July 1947. Problems included decisions on roles and missions and particularly with keeping Air Force hands off naval aviation and Army hands off the Marine Corps. As the leading witness in the so-called "revolt of the Admirals"--the hearings held by Carl Vinson's House Armed Services Committee--he supported the naval "radicals"--mostly aviators. He also objected so strenuously to the cancellation of the supercarrier United States by Secretary of Defense Louis A. Johnson that he became

persona non grata, not only to Johnson but to Secretary of the Navy Francis P. Matthews. Matthews "fired" Denfeld on 1 November 1949. Rather than accepting a new billet, Denfeld resigned after a career covering forty years.

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## BIOGRAPHY OF REAR ADMIRAL BOWEN HENDRY McCALLA, 1844-1910

Researcher: Professor Paolo E. Coletta

Rear Admiral Bowen Hendry McCalla saw the utility of steam engines in naval ships much more quickly than most others in the U. S. Navy. He served in various squadrons from 1865 to 1881, and was the Assistant to the Chief of the Bureau of Navigation, 1881-1887, when he also led an expedition to restore order in Panama during a revolution. He was then suspended from duty for three years as a result of a court-martial that found him guilty of striking a crewmember with his sword. He regained his numbers and was rewarded with extra ones for eminent and conspicuous service in the Spanish-American War (he took Guantanamo Bay), and in leading a relief expedition to the besieged legations in Peking in 1900. McCalla commanded the Bureau of Equipment branch at Mare Island, 1893-1897, and served as Commandant of the Mare Island Navy Yard from 1903 to 1906, when he was retired. During that last year he also helped people suffering from the San Francisco earthquake.

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## BIOGRAPHY OF CYRUS R. VANCE

Researcher: Professor Paolo E. Coletta

Research to date only includes collections of newspaper and magazine material, a partial bibliography, and the promise of cooperation from the Historian of the Office of the Secretary of Defense and the Historian of the Department of State.

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## ESSAYS ON NAVAL TOPICS

Researcher: Associate Professor Kenneth J. Hagan

This project consists of a series of about 15 short essays on naval topics being prepared for submission to Areté, a new encyclopedia being published by a house in Princeton, New Jersey. Topics include a general survey of naval history from ancient times to the present and biographical sketches of representative 19th-century American naval officers. The length of essays will vary.

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## EVOLUTION AND EDUCATION

Researcher: Associate Professor David E. Johnson

The goal of the project is to ascertain the implications for education of the facts of evolution of the species (especially the evolution of the human brain with its special functions) and of evolution of the individual (personal development). The focus has been on the work of the neurophysiologist Luria and the psychologist Piaget. In analyzing the implicit assumptions of contemporary higher education, it is shown how these assumptions work against the attainment of educational goals and result from the institutionalization of certain socio-economic values in our culture. The goals of (1) fostering well-rounded awareness of the culture, (2) upholding standards, i.e., achieving excellence, and (3) preparing qualified practitioners for the society are examined to see how they are undermined by assumptions incongruous with present knowledge of human development and learning. In order for this analysis to serve as a prelude to significant educational change, constructive proposals are introduced, following a description of the debilitating interrelationships of administration, faculty, and students in schools. The proposals involve an epistemological restructuring of the model-of-knowledge presentation during the first year of college, as well as an opportunity for de-schooling the schooled mind. The educational focus is on the student constituting himself (or herself) by means of purposeful activity and commitment within an academic structure that facilitates the meeting of personal and social needs.

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## LOYALTY AND EXPERTISE: THE TRANSFORMATION OF THE NINETEENTH-CENTURY GENERAL STAFF AND THE ORIGINS OF THE MODERN MILITARY ESTABLISHMENT IN AMERICA

Researcher: Assistant Professor William R. Roberts

Discussions of American military history in the nineteenth century are usually more descriptive than analytical. To detect in the events of this century, as recent military historians have sometimes done, an overall trend toward professionalization and administrative centralization is, to be sure, a step in the right direction of developing a suitable framework of analysis for this period. Yet historians and social scientists have so far failed to explain the precise relationship of these two processes to each other and why they took place when they did.

In order to answer these last two questions, this research focuses on one particular organization change--the creation of a modern American general staff in 1903. The general staff represented a major reform in civil military relations as well as in organization and administration and, as such, provides the historian with a unique opportunity to tie together a large number of disparate, antecedent events.

The research thus addresses two major, related questions: (1) why the American army adopted the general staff system, and (2) how that system contributed to the larger development of modern military organization. By tracing the demand for organizational reform in published and unpublished sources throughout the nineteenth century, it will be shown that the general staff was more than simply a response to a series of problems arising from the Spanish-American War, as previous historians have often asserted. As controversial as the latter war may have been, it was a precipitant rather than a cause of the organizational change in question. Moreover, by comparing the nineteenth-century Army with the Navy, those factors unique to the former can be isolated in order to clarify the causal relationships which contributed to the development of the general staff and the nascent centralization of command and administration evident in the Army after the turn of the century. Advocates of a general staff system were prominent in each branch of the service, yet in each instance the demands of men such as General William H. Carter and Admiral Henry C. Taylor elicited a noticeably different response. A comparative approach should lend itself not only to the clarification of causal relationships but also to a more meaningful treatment of subsequent organizational developments than has yet been achieved by those working wholly within the confines of military or naval history.

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#### THE UNITED STATES NAVAL ACADEMY: AN ILLUSTRATED HISTORY

Researcher: Assistant Professor Jack Sweetman

This project was undertaken with the aim of producing a concise history of the United States Naval Academy from its foundation to the present. The text, of approximately 60,000 words, will be complemented by some 200 illustrations and several maps. The narrative structure will be basically chronological, but enough background material will be supplied to enable the reader to appreciate the relationship between the Academy, the Navy it serves, and national policy. Recurrent themes will include the Academy's contribution to the rise and maintenance of American sea power; the development of Academy activities and traditions; evolution of the curriculum; the balance between education and training; buildings and monuments; Academy athletics; and profiles of outstanding superintendents, famous graduates, and colorful characters.

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THE ANTINAVALISTS, THE OPPONENTS OF NAVAL EXPANSION IN THE EARLY NINETEENTH CENTURY

Researcher: Assistant Professor Craig L. Symonds

This is a brief examination of the motivations of the opponents of naval expansion in the period 1800-1820. Research indicates that saving money was only one, and not the most important, of the reasons for opposing naval expansion. The real concern of the anti-Navalists was the mission of the Navy. The researcher will briefly review the historiography of this issue.

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NAVALISTS AND ANTINAVALISTS: THE NAVAL POLICY DEBATE IN THE UNITED STATES, 1785-1827

Researcher: Assistant Professor Craig L. Symonds

"The question is," said Albert Gallatin, "whether it be proper, at the present time, to lay the foundation of a navy, of a fleet, that might be able, hereafter, to give us a certain weight in relation to European nations." On the floor of the House of Representatives, the Congressional leader of the Republicans and the champion of government economy thus identified the central issue of the naval policy debate, a debate that was to persist intermittently for over three decades. As he expressed it, the issue was not whether the United States should build a navy at all, but whether a navy, once built, should be used as a counterweight in the European balance of power. This is an important distinction and one that has been largely ignored by naval historians of the early national period.

The common judgment of naval historians regarding this period of United States naval policy--that Republican opponents of the navy were irresponsible ideologues--falls apart when the full meaning of the naval policy debate is appreciated. It was the Navalists, driven as they were by impractical visions of a great and powerful United States holding the balance between supplicating European power blocs, who were promoting irresponsible national programs at a time when the United States had all it could do to hold the western Indians in check.

This is a new and fresh look at the American naval policy debate in the nineteenth century, one sure to excite controversy and criticism.

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THE SYKES-PICOT AGREEMENT OF 1916

Researcher: Associate Professor James P. Thomas

The purpose of this project is to investigate the causative factors in the British and French decision to agree upon the partition of the Arab portions of the Ottoman Empire and to provide for the creation of an independent Arab state during World War I. Emphasis is placed on elements of strategic interest, both of long-term and immediate wartime significance.

The agreement reached by Britain and France, the Sykes-Picot Agreement of 1916, has played an important role in the formation of the Arab attitude towards Britain and France. The agreement also had a bearing on the future of the Palestine area.

Material acquired at the British Public Record Office, at the French Ministry of Foreign Affairs Archives, and in various collections of private papers is in the process of being incorporated into this study.

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A HISTORY OF THE NATIONAL RESOURCES PLANNING BOARD, 1933-1943

Researcher: Associate Professor Philip W. Warken

The National Resources Planning Board was the first attempt to introduce systematic planning into the federal government. This study is based on a review of the secondary literature of the New Deal and on extensive work in primary documents in the Roosevelt Library, the Library of Congress, and the National Archives. The records of the NRPB and related agencies were utilized, and this is the first, and so far the only, work to be based on these documents. The study traces the evolution of the board from its inception in 1933 as the National Planning Board to its installment in 1939 in the Executive Office of the President as the NRPB. Its various projects included public works planning, development and conservation of natural resources, studies of population and consumer spending, defense and war-related activities, and efforts to solve the problems growing out of industrial congestion in the major industrial centers. The NRPB became deeply involved in planning for the post-war years. Its advanced recommendations for social and economic improvement provoked the opposition that helped to abolish it in 1943.

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CALDERHEAD, William L., Professor, "A Strange Career in a Young Navy: Captain Charles Gordon, 1778-1816," Maryland Historical Magazine, 72 (Fall 1977), 373-384.

This article analyzes the naval career of a Marylander from the Eastern Shore who entered the Navy in 1799, served in the Quasi-War with France, was in the Chesapeake-Leopard Affair, and served with honor and distinction in the War of 1812 which followed. Gordon's career was typical of that of the more famous hot spurs of the day, represented by figures like Decatur, Perry, Lawrence, and MacDonough.

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CALDERHEAD, William L., Professor, "The Role of the Professional Slave Trader in a Slave Economy," Civil War History, 23 (September 1977), 195-211.

This article describes the activities of Austin Woolfolk, one of the most active professional slave traders in border state South in the 1820's and 1830's. Historians had always assumed that the trader gathered great wealth and used extremely inhumane techniques in rounding up slaves and selling them South. In the process it was also felt that he distorted the demographic balance of the slave population in the border areas.

The article proves that there was little profit in the business, that techniques of trading were not particularly inhumane, and that the trade did little to distort the demographic balance.

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COLETTA, Paolo E., Professor, "Bowman Hendry McCalla and the Spanish-American War," Shipmate, 41 (June 1978), 25-28.

Commanding the light cruiser Marblehead, McCalla served in Schley's Flying Squadron until it reached Cuba and finally found Cervera's ships at Santiago. After about six weeks of blockade duty, McCalla was sent to take Guantanamo Bay so that it could be used as a logistic support base for Admiral William Sampson's fleet. McCalla, supported by Marines, secured the bay, swept mines, and cut cables (as he already had done at Cienfuegos). In his honor, the Marines at Guantanamo named their base Camp McCalla.

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COLETTA, Paolo E., Professor, "French Ensor Chadwick," Shipmate, 40 (September 1977), 31-32.

This article traces the reasons Chadwick applied for admission to the Naval Academy and his training at the Academy while it was at Newport during the Civil War. It details his service on numerous ships, as a teacher of mathematics at USNA, 1872-1875, as the first naval attache to London, 1882-1889, and as commanding officer of the Yorktown in the Squadron of Evolution (1889-1891). He also served as the Chief of ONI, 1892-1893; Chief, Bureau of Equipment, 1893-1897; commanding officer of the cruiser New York, and chief of staff to Rear Admiral William Sampson during the Spanish-American War; President of the Naval War College and member of the General Board, 1900-1903; and as Commander, South Atlantic Squadron from 1904 to his retirement in 1906. He then wrote four volumes of naval and diplomatic history, a book on the causes of the Civil War, and numerous articles.

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COLETTA, Paolo E., Professor, "John T. Raulston," in John Garaty, ed., Dictionary of American Biography, New York: Charles Scribner's Sons, 1978.

Raulston obtained legal training and served various large corporations until he was elected to the Tennessee legislature and then to a judgeship. As a judge he presided over the famous "Scopes Trial" of 1925 that among others pitted William Jennings Bryan against Clarence Darrow. Defeated shortly thereafter, he returned to the law and served railroads and other large corporations.

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COLETTA, Paolo E., Professor, "Recognition Policy," in Alexander De Conde, ed., Encyclopedia of American Foreign Policy, New York: Charles Scribner's Sons, 1978.

This is one of the 92 essays that deal with various aspects of American foreign policy. The essay covers two main topics: recognition in peacetime, and recognition of belligerents and neutrals in time of war. The basic doctrine of recognition, as established by Thomas Jefferson when he was Secretary of State, was to grant de facto recognition when a political organization could preserve order and enjoyed the support of most of the people in a given area. Violations of this doctrine were made by Woodrow Wilson (in Mexico) and subsequent presidents (in Mexico, Nicaragua, Manchuria). The current trend is to return to the basic doctrine. Recognition policy in time of war has practically been abandoned because wars are no longer declared.

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COLETTA, Paolo E., Professor, The American Naval Heritage in Brief, Washington, D. C.: University Press of America, 1978.

In outline form, this book deals with the transfer of naval technology and doctrine from Europe, especially from Great Britain, to the British colonies and to the United States up to World War I. It covers the history of colonial and national wars, battles, naval administration, the functions of the Navy in peace and war, and the status of the U. S. Navy with respect to the USSR and SALT. An extensive bibliography contains Library of Congress call numbers.

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COLETTA, Paolo E., Professor, "The Nerves' of the New Navy," American Neptune, 38 (April 1978), 122-130.

The careers of Bradley A. Fiske and French Ensor Chadwick are used to describe how interior communications were provided to the ships of the New Navy, 1882-1900. Fiske (USNA, 1874), invented many of the devices that made a ship brighter, lighter, more efficient, and more healthful: lights, telephones, helm-angle indicator, after-steering, turret-turning, flashing-light signaling-system, ash and ammunition hoists, winches, fire-control communications and range-finders permitting continuous aim battery fire, and the engine order telegraph.

As the first naval attache at London, 1882-1888, Chadwick (USNA, 1864), reported on advances being made in European ship construction, including electrical systems and apparatus. As Chief of the Bureau of Equipment, 1893-1897, he was responsible for installing and repairing all electrical equipment in ships and stations. The Trenton, 1882, the first American naval vessel to be electrified, could light 250 incandescent lamps. In 1897, Chadwick provided electrical installations for 13 new ships, including the battleships Iowa and Oregon and plans for the follow-on battleships Illinois, Wisconsin, and Alabama, the last using two 50 KW generators and three of 32 KW for a total of 197 KW, while the Kentucky and Kearsarge had seven 50 KW sets for a total of 350 KW.

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COLETTA, Paolo E., Professor, "William Jennings Bryan's Plan for World Peace," Nebraska History, 58 (Summer 1977), 193-218.

Bryan's passion for peace received an outlet when he became Secretary of State, 1913-1915. From his earlier interest in solving capital-labor problems, he suggested non-binding arbitration for international disputes. If agreement could not be reached he would use a "cooling off" system in which commissions comprised of men of the contending states and neutrals would take a year to study the problem and then make a report--the idea being that war, stopped for a year,

would probably not ensue. He wrote thirty treaties, but the signatories did not include German and Japan, and hence were of little value in preventing World War I. However, the idea of conciliation has been adopted by the League of Nations and the United Nations.

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HAGAN, Kenneth J., Associate Professor, co-author, American Foreign Policy: A History, Lexington, Massachusetts: D. C. Heath and Company, 1977.

This book is a comprehensive survey of the history of American foreign relations from colonial times to the present. The dominant theme is that of inexorable American expansion.

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HAGAN, Kenneth J., Associate Professor, editor, In Peace and War: Interpretations of American Naval History, 1775-1978, Westport, Connecticut: Greenwood Press, 1977.

This book contains original essays by 17 authors. The arrangement is chronological, spanning the entire history of America's naval experience. The interpretations are the authors' own, and they range from traditional Cold Warriorism, through thoroughly balanced assessments, to rampant revisionism.

\*\*\*\*\*

HAGAN, Kenneth J., Associate Professor, "Nuclear Weapons and Diplomacy," in Alexander De Conde, ed., A Dictionary of the History of American Foreign Policy, 3 volumes, New York: Scribner's, 1978.

This essay examines the interrelationship between nuclear weapons and American foreign policy since the Second World War. It traces the American attempt to maintain a nuclear monopoly, the Soviet acquisition of nuclear weapons, and the gradual acceptance by American leaders of the idea first advanced in 1946 by Bernard Brodie: only through a balance of terror is peace likely to be maintained in the nuclear age.

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HARROD, Frederick S., Assistant Professor, Manning the New Navy: The Development of a Modern Naval Enlisted Force, 1899-1940, Westport, Connecticut: Greenwood Press, 1978.

When the United States emerged as a major naval power after the Spanish-American War, its new steel warships were visible proof of the changed nature of the navy. Equally important, but less obvious, was the transformation of the enlisted personnel system. Because the manpower

practices of the sailing navy could not provide the large numbers of men and the technicians the new fleet demanded, established methods of recruiting and treatment of sailors had to be altered. In the process, the navy developed the foundations of its modern personnel system.

The nineteenth-century service had filled its crews with professional mariners recruited from coastal cities of the United States and in the ports of the world. These men stemmed largely from seafaring traditions and required little or no training before shipboard assignment. Sailors rather than navy men, they moved freely between the navy and the merchant marine.

The old personnel system persisted as long as the navy's need for men remained small. The enlarged requirements of the twentieth-century fleet meant the navy had to seek other sources of manpower. Instead of relying solely on coastal areas, the department began enlisting men from inland regions of the United States, simultaneously developing a nationwide recruiting service and modern advertising techniques to attract men without maritime backgrounds.

Because most of the men that the new recruiting system provided were landsmen, the navy had to provide comprehensive basic training for all new enlistees. It also instituted trade schools and technical courses to prepare men to operate the equipment aboard modern warships.

Having invested considerable effort and expense in the recruiting and training of bluejackets, the department also sought to encourage men to remain in the navy by improving the conditions of service. Among other measures, it adopted a retirement program, provided recreational facilities, and upgraded shipboard habitability.

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JOHNSON, David E., Associate Professor, "Russell on General Facts,"  
Library of the Bertrand Russell Society, (21 January 1978), 1-9.

The issues covered are taken from the celebrated "Lectures on Logical Atomism," (1918) by Bertrand Russell. The paper, "Russell on General Facts," defends Russell's position against critics, specifically Professor Ausonio Marras of the University of Western Ontario, Canada. Russell argues that in order to do justice to important features of logic and mathematics, one must include general facts in his view of reality, in addition to particular facts. In other words, the sentence "All men are mortal" states something different from a sentence listing each

particular man and saying of each that he is mortal. The focus of the controversy is what is required in order to account for the meaning and the truth of general propositions. The paper argues that a collection of particular facts does not provide a sufficient condition for the truth of a general proposition.

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PRICOLO, Dennis M., Midshipman 1/C, "Naval Presence and Cold War Foreign Policy: A Study of the Decision to Station the Sixth Fleet in the Mediterranean, 1945-1958," Trident Scholar Project Report Number 95, U. S. Naval Academy, Annapolis, 1978.

The study deals with the origins of the U. S. Sixth Fleet and its role in the Mediterranean region in the aftermath of World War II. The research is based on great themes. First the postwar American strategists and foreign policymakers reacted to hostile moves by the Soviets with great hesitancy since they lacked sufficient force to uphold a policy of greater stiffness. The second theme is the enduring utility of naval power, and its richness and flexibility.

\*\*\*\*\*

SWEETMAN, Jack, Assistant Professor, "Coronel: Anatomy of Disaster," in Gerald Jordan, ed., Naval Warfare in the Twentieth Century: Essays in Honour of Arthur Marder, New York: Crane, Russak, 1977, pp. 70-89.

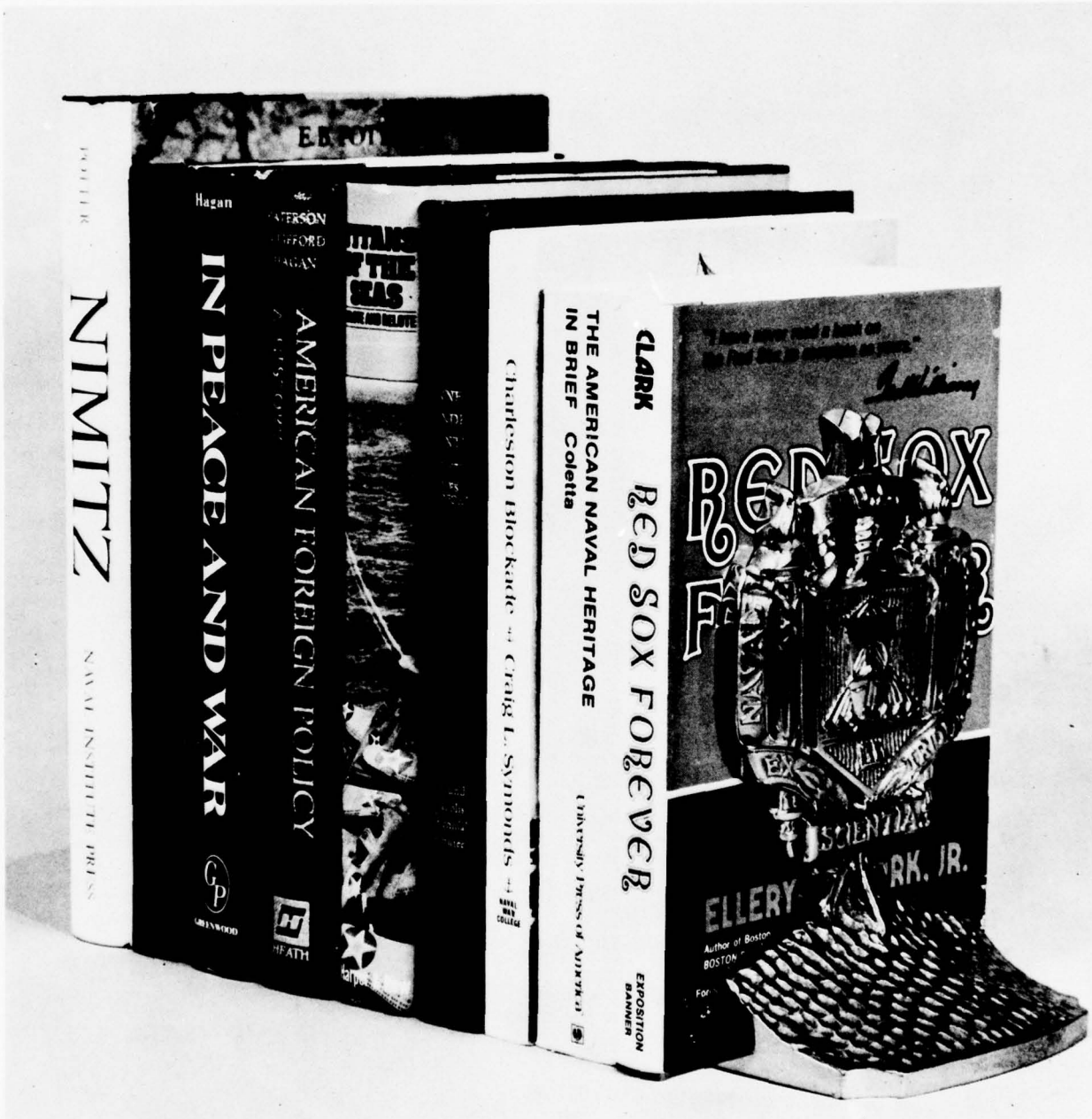
On 1 November 1914, a British cruiser squadron commanded by Rear Admiral Sir Christopher Cradock was defeated by a superior German squadron at the battle of Coronel. Cradock himself was lost when his flagship, HMS Good Hope, went down with all hands. The action has been described in more or less detail by British and German participants and historians, and its course is not subject to question. The question is why Cradock, an experienced and intelligent admiral, deliberately engaged a force which, as he well knew, was so far superior to his own that the outcome was virtually a foregone conclusion.

Various answers have been proposed. They range from quixotic gallantry to a grossly inaccurate estimate of the situation. This paper seeks to reconstruct the reasons for Cradock's fatal decision through a detailed analysis of his orders from and messages to the British Admiralty in the weeks preceding the action. The manner in which Cradock's temperament and state of mind influenced his interpretations of events is also explored. The paper concludes that the disaster at Coronel was primarily a tragedy of communications, which led Cradock to believe that he was expected to attack the German squadron regardless of the odds.

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SWEETMAN, Jack, Assistant Professor, "Notable Naval Books of 1977,"  
U. S. Naval Institute Proceedings, 104 (January 1978), 101-105.

A total of sixteen titles were selected for this annual survey of the most outstanding books on naval and maritime subjects published in 1977 or too late in 1976 for inclusion in last year's survey. Topics of the works range from history to biography to current affairs.



BRADFORD, James C., Assistant Professor, "American Colonial Slavery and Alex Haley's Roots," St. Mary's College's "Early Maryland and the World Beyond," St. Mary's, Maryland, 6 October 1977.

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COLETTA, Paolo E., Professor, "Rear Admiral French Ensor Chadwick," Monongalia County Historical Society, Morgantown, West Virginia, 19 May 1978.

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HAGAN, Kenneth J., Associate Professor, "The History of American Naval Strategy," Department of State, Foreign Service Institute, Washington, D. C., December 1977.

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LOVE, Robert W., Jr., Assistant Professor, "Admiral Leahy, FDR, and American Naval Rearmament," Conference on War and Diplomacy, The Citadel, Charleston, South Carolina, 11 March 1978.

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SYMONDS, Craig L., Assistant Professor, "Search for a Maritime Strategy," U. S. Marine Corps Command and Staff College, Quantico, Virginia, October 1977.

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SYMONDS, Craig L., Assistant Professor, "The Union Blockade of the Confederacy, A Reconsideration," The Civil War Round Table of New Jersey, 5 January 1978.

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SYMONDS, Craig L., Assistant Professor, "Admiral Pratt and American Naval Policy," Conference on War and Diplomacy, The Citadel, Charleston, South Carolina, 9 March 1978.

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THOMPSON, Larry V., Professor, "The Army in Wilhelmine Germany: Technological Innovation, Social Change, and Policy Confusion," U. S. Marine Corps Command and Staff College, Quantico, Virginia, 7 February 1978.

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DIVISION OF  
MATHEMATICS AND SCIENCE



## APPLIED SCIENCE DEPARTMENT

*Commander Kenneth G. Clark, USN, Chairman (July 1977 - May 1978)*

*Major W. Andrew Hesser, USMC, Chairman, (May 1978 - June 1978)*

The research performed within the Applied Science Department reflects the wide range of expertise present in the Department's three disciplines: Resources Management, Operations Analysis, and Computer Science. The Operations Analysis Study Group was supported by an annual grant from the Chief of Naval Operations (OP-953). The funds provided assisted the Group in conducting a "cooperative program of operations research studies in Tactical Development and Evaluation in all warfare areas with faculty members working on joint tasks with the Office of the Chief of Naval Operations (OP-953) and Fleet Tactical Development and Evaluation activities."

Another category of research by the Operations Analysis Study Group is "in-house" analysis, in support of Naval Academy operations or programs, on an as-requested basis. The Graduate Performance Evaluation System (GRAPES) is a continuous activity in this category.

Pioneering work in Brain Wave analysis was continued by one member of the faculty, evoking nationwide interest in the research performed.

In the Computer Science area a microprocessor-based laser transmission system was developed. Further research continues to develop the software required for microcomputer systems' use in ship-to-ship communications.

The large number of midshipmen projects reflects the Department's belief that student research under the supervision of an interested and dedicated faculty is a broadening and valuable educational experience. The opportunity to utilize the knowledge and skill gained during the prior three intensive years of work gives First Class Midshipmen an appreciation and understanding of the usefulness and importance of their education.

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ACTIVITIES ASSOCIATED WITH SUCCESSFUL COMPANY COMMANDER OPERATIONS

Researchers: Ensign Jack Bernard, USN, and Associate Professor Karel Montor

Sponsor: Naval Recruit Training Center, Orlando

The project's purpose was to perform a preliminary evaluation of the Critical Incident method for determining those characteristics possessed by successful recruit training Company Commanders. The study resulted in a comprehensive listing and identification of those actions that are being taken by Company Commanders who are doing their jobs successfully.

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GRADUATE PERFORMANCE EVALUATION SYSTEM (GRAPES)

Researcher: Lieutenant Commander Roland T. E. Bowler III, USN

Sponsor: Naval Academy (Division of Professional Development)

Serving as a form of USNA self-accountability, GRAPES captures the (1965, 1970, and 1974) graduate's appraisal of his preparation for effective and competitive service as a junior officer. Analysis of the individual questionnaire responses provides identification of specific strengths and weaknesses of the USNA program, for these responses are based upon several years of personal experiences by these young men as midshipmen and as junior officers.

It is the long-term goal of GRAPES to join such graduate feedback with an objective measure of graduate success in the military profession. Such a measure would represent an annual, macroscopic appraisal of the total USNA program (including the admissions sub-program) for year-to-year comparison among USNA graduating classes and for comparison between USNA and competitive commission sources.

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NEUROLOGICAL ANALYSIS OF THE BRAIN WAVE RECORDS OF THE CLASS OF 1980

Researcher: Associate Professor Karel Montor

Sponsor: Office of Naval Research (Code 441)

The purposes of this investigation were: (a) To analyze visual-evoked brain electrical responses of a large sample of patients diagnosed as having various neurological disorders and to attempt to establish relationships between the characteristics of the brain response, diagnostic

category and behavior; (b) To continue EEG analysis of USNA midshipmen data and attempt to relate characteristics of the brain response to academic and/or physical education performance, and (c) To develop inexpensive remote recording systems that will permit long-distance cooperative research with others. Activities (a) and (b) are continuing and (c) has been completed.

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EFFECTS ON PERSONNEL IN A GAS-TURBINE POWERED-ENCLOSED LVA DURING TRANSIT ON THE SURF ZONE

Researchers: Midshipmen 1/C Timothy P. Benson and Roscoe A. Godfrey

Adviser: Major Edward A. Smyth, USMC

Sponsor: Chief of Naval Operations (OP-95)

The landing craft currently used by the United States Marine Corps is diesel-powered with speeds from 6 to 8 knots. This causes the distance of the amphibious ships to be within range of recently developed surface weapons. In order to increase this distance as well as increase the speed of both the craft and the amphibious operation, the Marine Corps is considering replacing the diesel engine with a gas turbine engine. Gas turbine engines, however, have the potential to cause considerable problems for the troops on board.

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MAD SEARCH: A SENSITIVITY ANALYSIS

Researchers: Midshipmen 1/C Robert J. Fallon and Jerry C. Swartz

Adviser: Lieutenant Commander Gilbert M. Marlowe, USN

Sponsor: Chief of Naval Operations (OP-95)

Magnetic Anomaly Detection (MAD) gear aboard an ASW aircraft is modeled for submarine search purposes. The limited range of MAD gear is optimized through the use of carefully constructed aircraft tracks to provide maximum MAD coverage over a given area. A tactical aircraft track is modeled, following detection, to confirm submarine's course and speed.

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DETERMINING THE OPTIMAL MIX OF TRANSPORT HELICOPTERS NEEDED TO SUPPORT A MARINE AMPHIBIOUS UNIT

Researchers: Midshipmen 1/C Raymond J. Fritsch and Michel J. Makowicz

Adviser: Major Edward A. Smyth, USMC

Sponsor: Chief of Naval Operations (OP-95)

The CH-46E is the primary transport helicopter in the Marine Corps today. The recent introduction of a new transport helo, the CH-53E, inspired this project. This report presents the results of research conducted with the objective of determining the optimal mix of CH-53Es and CH-46Es needed to support a Marine Amphibious Unit in an amphibious assault.

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AN EVALUATION OF THE TACTICAL USE OF A TRIANGULAR ATTACK METHOD OF MK46 TORPEDOES BY A P-3 AIRCRAFT

Researchers: Midshipmen 1/C Douglas D. Grau and Robert L. Schwaneke

Adviser: Associate Professor W. Charles Mylander

Sponsor: Chief of Naval Operations (OP-95)

Presently, when a submarine is detected by a P-3 aircraft using sonobuoys, the target is localized first and then attacked. It is proposed that an investigation be made into the possibility of omitting the localization step and immediately launching an attack using three strategically placed MK46 torpedoes. This project develops a computer simulation that calculates an estimate for the probability of success when using this method of attack.

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P-3C ENGINE PERFORMANCE: HAND-HELD CALCULATOR PROGRAMS TO SOLVE OPTIMAL POWER SETTINGS

Researchers: Midshipmen 1/C Norman T. Hansen and Mark W. McNair

Adviser: Lieutenant Commander Gilbert M. Marlowe, USN

Sponsor: Chief of Naval Operations (OP-95)

The P-3C patrol aircraft performs its mission utilizing maximum range and loiter operations. The Engine Performance Tables contained within the NATOPS manual are presently used to calculate the optimum power settings for these two modes of operation. Recently, each P-3C flight crew has been provided with the programmable HP-67 calculator. It is desired that programs be written to perform the function of the Engine Performance Tables.

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AN ANALYSIS OF THE SONOBUOY MONITORING CYCLE

Researchers: Midshipmen 1/C James W. Kain and George M. Koucheravy

Adviser: Lieutenant Commander Gilbert M. Marlowe, USN

Sponsor: Chief of Naval Operations (OP-95)

Present aircraft systems allow for simultaneous monitoring of sixteen sonobuoys. The use of additional time-shared sonobuoys could expand the search area or increase the probability of detection within a given area. This study, using the sonobuoy Search Pattern Analysis Model (SPAM), gives evidence to show that a monitoring schedule using additional sonobuoys would increase the probability of detection of a transiting target.

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THE EFFECTIVE ARMING OF THE CH-46E

Researchers: Midshipmen 1/C Thomas V. Manobianco and Bradford H. Baylor

Adviser: Major Edward A. Smyth, USMC

Sponsor: Chief of Naval Operations (OP-95)

One costly result of the Vietnam War showed that our helicopters, particularly the CH-46 transports, were extremely vulnerable to enemy attack. Presently, the Marine Corps is evaluating various weapon and sensor systems to be placed on board the CH-46 in an effort to increase

its effectiveness and survivability. This study is a comparison between the current base-line CH-46 and the predicted 1982 base-line CH-46. This comparison examines the feasibility of these various systems and their effects on survivability and troop-carrying capacity of the helicopter.

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URBAN WARFARE: FIGHT OR DEFEND

Researchers: Midshipmen 1/C Tony G. Martin and Michael E. King

Adviser: Major Edward A. Smyth, USMC

Sponsor: Chief of Naval Operations (OP-95)

An urban scenario is built around two simulation models to predict the kill-probabilities of attackers and defenders. Weapons' rate of fire, attacker speed, and number of men in cover team are analyzed for the offensive force. The optimal height is determined for the defensive forces.

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EVALUATION OF THE PENTAC SONOBUOY PATTERN

Researchers: Midshipmen 1/C John A. O'Neil and Daniel D. Serfass

Adviser: Associate Professor W. Charles Mylander

Sponsor: Chief of Naval Operations (OP-95)

This project compares the effectiveness of a newly-developed sonobuoy pattern, the pentac pattern, and the distributive field pattern. The two patterns are compared within three different scenarios in which a distributive field sonobuoy pattern would be used. The results of this study showed no significant differences in the mean probabilities of detection for the two patterns.

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SEARCH STRATEGY FOR A SPECIFIC DICHOTOMOUS TARGET LOCATION SCENARIO

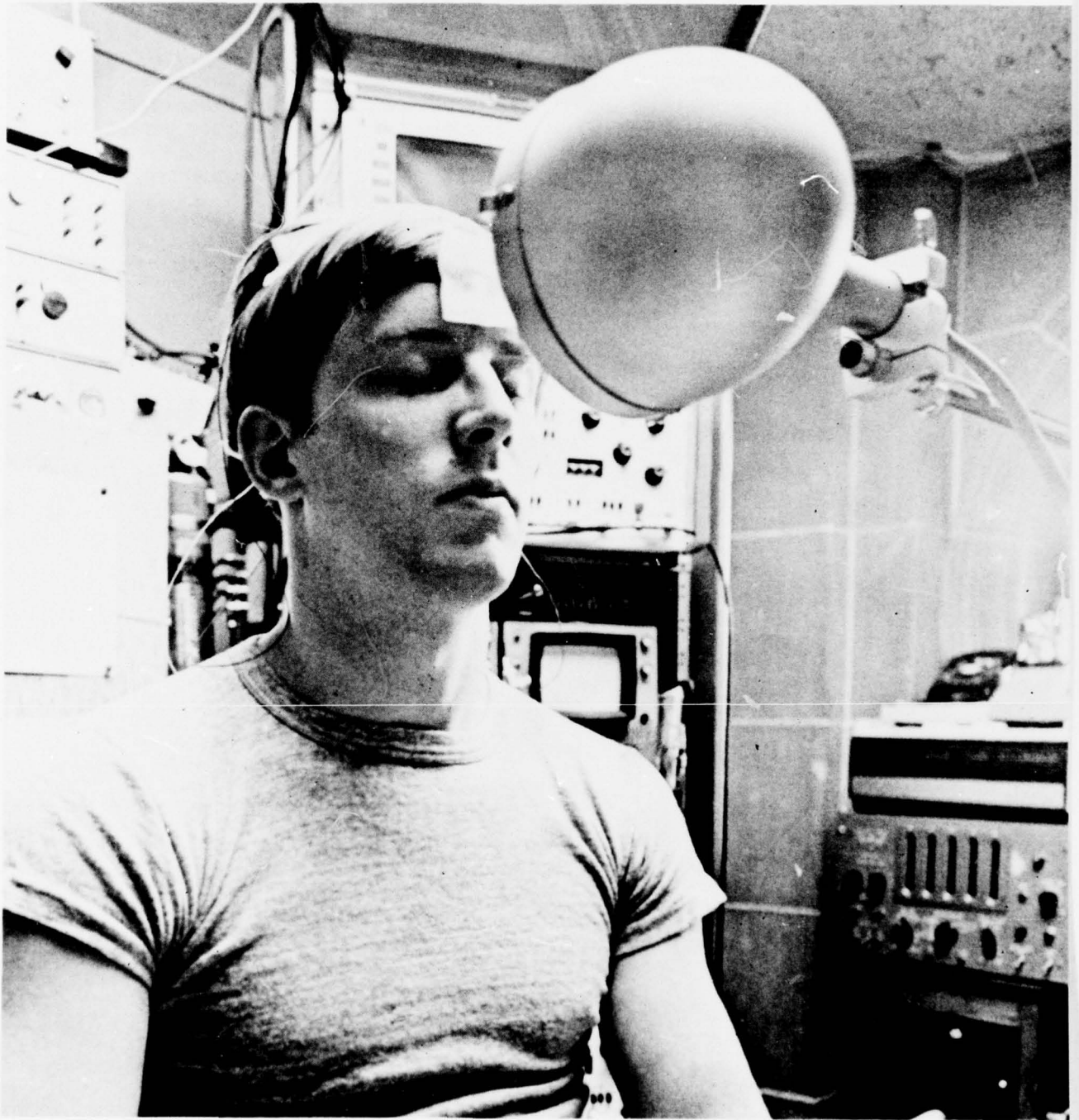
Researchers: Midshipmen 1/C Christopher L. Powers and Donald E. Vance II

Adviser: Commander James L. Bagby, USN

Sponsor: Chief of Naval Operations (OP-95)

An analytical model is developed that will assist a searcher faced with the following scenario:

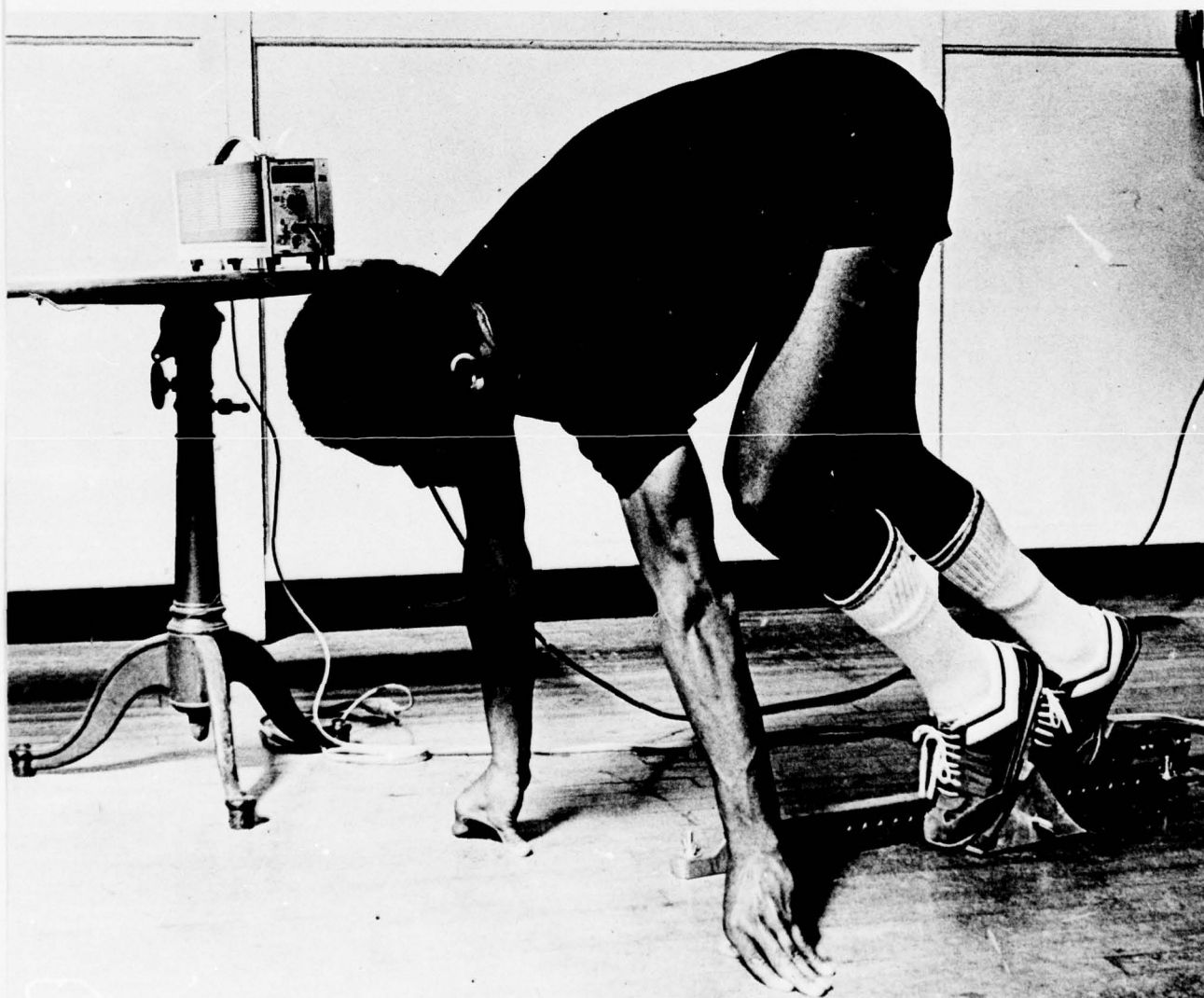
The target's position has been determined to be located within a small circle of radius  $R$ . By the time,  $T$ , a searcher can get on station for his search and subsequent mission-action after detection, the target will either still be within this fixed circle or will be on an expanding ring opening its original position at some estimated speed.



USING PIES TO ANSWER QUESTIONS ABOUT THE U. S. ENERGY FUTURE

Researchers: Associate Professor W. Charles Mylander, et al.

This paper describes the use of the Project Independence Evaluation System (PIES) which was developed at the Federal Energy Administration under leadership of William Hogan shortly after the oil embargo of 1973. Many enhancements to the underlying models in PIES, as well as advances in implementation, have been made since its first application to prepare the Project Independence Blueprint (1974) and the National Energy Outlook (1976). The focus of this exposition is on the underlying principles and the kinds of questions PIES helps to answer, particularly those pertaining to analysis of policy initiatives.



## ACADEMIC PREDICTORS FOR SUCCESSFUL COMPLETION OF THE OPERATIONS ANALYSIS CURRICULUM

Researchers: Midshipmen 1/C Jack B. Adolph and Randolph T. Kahn

Adviser: Lieutenant Commander Gilbert M. Marlowe, USN

Operations Analysis is unique among the mathematically-based disciplines in that, for one thing, problem formulation is a major aspect of ultimate solution. Many students have difficulty with this facet of the problem and some are not able to overcome this difficulty. It may be too late for a midshipman in this situation to switch to another major. By employing multiple regression analysis, a model predicting one's success in Operations Analysis will identify those students early enough so they can switch to a major more in line with their capabilities.

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## AN ANALYSIS OF THE SERVICE SELECTION DECISION PROCESS AT THE UNITED STATES NAVAL ACADEMY

Researchers: Midshipmen 1/C Arthur J. Athens and Gerald S. Cory

Adviser: Commander James L. Bagby, USN

The Academy spends considerable resources on the Service Selection Preparatory Program in order to properly prepare midshipmen for their Warfare Specialty choice. The administration has observed a great deal of vacillation up to and including Service Selection Night. Because of this vacillation, it is most difficult to predict the final outcome of the Service Selection process. Perhaps the Preparatory Program is not accomplishing its established mission.

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## A SURVEY OF MIDSHIPMAN ATTITUDES TOWARD THE NAVAL ACADEMY HONOR CONCEPT

Researcher: Midshipman 1/C Gregory J. Baur

Advisers: Assistant Professor Robert E. Steed and Commander Larry E. Barringer, USN (Office of the Commandant of Midshipmen)

A survey of midshipman attitudes toward the USNA honor concept was developed and completed. The results have not been analyzed and evaluated at this time.

A second goal is to examine the organization of the honor committees and to identify areas of weakness. This study has led to the formulation of twelve specific recommendations for managerial changes to the organization. Eight recommendations have been approved, and four are still pending.

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AN ANALYSIS OF REENLISTMENT RATES VERSUS INSPECTION POLICIES OF THE UNITED STATES NAVY

Researchers: Midshipmen 1/C Phillip B. Benoit and Robert H. Shinskie

Adviser: Lieutenant Commander John F. Sigler, USN

In recent years there has been growing concern over the low reenlistment rates in the United States Navy. A major part of this concern has centered about the critical enlisted engineering ratings, specifically, Boiler Technicians (BT) and Machinist Mates (MM), which not only have lower reenlistment rates than other ratings, but also appear to have more negative trends. There exists a perception that this apparent discrepancy can be, at least partly, attributable to the Propulsion Examining Board (PEB). The PEB was instituted at the close of the Vietnam conflict to improve the engineering operational readiness of the U. S. Fleet, which had slipped badly due to war year commitments. This project investigates the possibility of a correlation existing between the PEB and these reenlistment rates.

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AN ANALYSIS OF NAVAL AVIATION TRAINING (PILOT AND NFO) ATTRITION RATES BY COMMISSIONING SOURCE

Researchers: Midshipmen 1/C Gary W. Boettcher and Cabell Greenwood

Adviser: Lieutenant Commander Roland T. E. Bowler III, USN

The Graduate Performance Evaluation System (GRAPES) is an in-house Naval Academy program designed to collect and evaluate data on graduate performance. As an adjunct to GRAPES, Naval Academy graduate performance at the various warfare specialty schools is analyzed. This project examines the attrition rates of Naval Academy graduates who attended Naval Aviation Training, either Pilot or Naval Flight Officer, versus the attrition rates of trainees from other commissioning sources. The attrition rates analyzed include the period FY 1968-1978.

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## FOOD SERVICES MENU INFORMATION SYSTEM

Researchers: Midshipmen 1/C David W. Bruce and Michael R. Shumaker

Adviser: Research Professor Thomas D. Burnett

The Midshipmen Food Service Division prepares meals for 4300 midshipmen. Menu production involves calculating the quantities of ingredients required to cook the meals. This is currently a manual operation and is complicated by such factors as acceptability percentage and the percent to add to meal count. A system is developed to create and maintain data files in order to perform the required calculations by computer while having a minimal impact on other operations within the Midshipmen Food Service Division. This system forms the core of a management information system encompassing all Midshipmen Food Service Division operations.

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## FORECASTING FUTURE FORCE LEVELS OF THE MARINE CORPS STAFF NON-COMMISSIONED OFFICERS

Researchers: Midshipmen 1/C Gregg W. Burgess and John R. Kovalcik

Adviser: Associate Professor W. Charles Mylander

This study examines the effect of the declining population pool of qualified military applicants and that of the all-volunteer force on the Marine Corps enlisted structure. A simulation model that utilizes the Markovian Process is constructed to forecast future force levels of the staff non-commissioned officers. The probabilities of promotion and attrition are altered in a sensitivity analysis to examine possible alternatives/recommendations for Marine Corps Headquarters in Washington, D.C.

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## ACADEMIC PROGRESS GRADES: GOOD PREDICTORS, GOOD MOTIVATORS, BOTH, OR NEITHER?

Researchers: Midshipmen 1/C Fred A. Butterfield III and John V. Kauffman

Adviser: Commander James L. Bagby, USN

The U. S. Naval Academy is presently using an academic reporting system whereby the fourth, tenth, fourteenth, and final grades are reported. It is desired to investigate the worth of the grades of these first three periods in predicting a midshipman's final grade and in motivating his ultimate performance. Various other factors, such as class year, QPR, and academic discipline will also be investigated as to their effect on the "predictability" and "motivation effect" on progress report grades for midshipmen.

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## DESIGN OF A MICROPROCESSOR-BASED DATA COMMUNICATION INTERFACE

Researcher: Midshipman 1/C Robert S. Dirickson

Adviser: Lieutenant John F. Arfman, Jr., USN

As the size of data handling operations increases with a corresponding increase in the volume of data which must be transferred between points, it becomes increasingly important that data transfer operations be executed as quickly as possible with the equipment available. The data line between the Academic Computing Center's Honeywell 635 and CADIG's Digital PDP-11 in Rickover Hall is a convenient and important example of where high speed data transfer would prove beneficial.

This project involves the establishment of a 4800-bits-per-second synchronous communication link between the H635 and the PDP-11. In order to make this link transparent with respect to the receiving computer, all protocol formatting and error checking will be done using a microcomputer built around a ZILOG Z-80 microprocessor. The microcomputer will receive synchronous serial data from the H-716 communications processor and present 8-bit parallel data characters to the PDP-11 after performing protocol deframing and error checks. Transmission from the PDP-11 to the H635 will be the mirror image of this process.

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## PREDICTING MIDSHIPMAN PERFORMANCE

Researchers: Midshipmen 1/C Scot A. Miller and Jonathan E. Will

Adviser: Commander James L. Bagby, USN

The U. S. Naval Academy's Candidate Guidance Office ranks the applicants for each year's midshipman class and then offers admission to the best applicants. The candidates are ranked by predicting their future overall midshipman performance. This prediction is generated by a model called the Whole Candidate Multiple (WCM), which uses high school performance as inputs. It is desirable to increase the accuracy of the performance prediction. Using as inputs the WCM and various psychological and physical characteristics of the candidates, an improved model is developed and discussed.

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DESIGN OF A MICROPROCESSOR INFRARED DATA SYSTEM PROTOTYPE

Researcher: Midshipman 3/C Pardner Wynn

Adviser: Lieutenant Commander Jay A. Sears, USN

The MIDS project is a prototype data system developed with naval short range tactical communications in mind. The premise behind the project is that an optical computer data link would be a simple, effective method to securely send short range intership messages in a variety of visibility conditions. Its operation is simple and direct, geared (but not limited) to an ATP format. The system is comprised of two Intel 8080a microprocessors, a laser diode transmitter, a photodiode receiver/amplifier, and associated interfacing. While presently limited in practical use, it provides a good demonstration of generalized and application-specific hard- and soft-ware design techniques necessary to effect microcomputer-to-outside world interfacing.

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BURNETT, Thomas D., Associate Professor, and Gilbert M. MARLOWE, Lieutenant Commander, USN, "An Analysis of Company Academic Performance at the U. S. Naval Academy." USNA In-House Study, December 1977.

This study was principally concerned with academic performance by company. The results of the study can be summarized as follows: Many relationships between a midshipman's academic potential and major and his performance are identified and the consequences of taking these into account in measuring performance are explored; no readily accessible predictive indicators of performance were identified; a summary profile of the basic make-up of each company, their raw and adjusted academic performance, their military performance, and their ECA and athletic participation is presented as a management tool for obtaining a statistical overview of a company and for identifying performance problem areas and suggesting solutions; the results of an analysis of the effect of company officer on company performance is presented. A discussion is presented of the feasibility and magnitude of the task implementing some of the procedures developed in this study on an ongoing basis.

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BURNETT, Thomas D., Associate Professor, co-author, "A Nonparametric Analog of Analysis of Covariance." Educational and Psychological Measurement. 37 (1977), 341-348.

A nonparametric test of the hypothesis of no-treatment effect is suggested for a situation where measures of the severity of the condition treated can be obtained and ranked both pre- and post-treatment. The test allows use to be made of the pre-treatment rank as a "comcomitant variable," and is based on the nature and degree of permutation of the post-treatment ranks relative to the pre-treatment ranks. Evidence is given which shows that the distribution of the suggested test statistic rapidly approaches the  $F$  distribution as the number of subjects is increased. For small samples, a randomization may be performed.

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OPERATIONS ANALYSIS STUDY GROUP, Naval Operations Analysis. U. S. Naval Institute, 1977.

This work created the Second Edition of this textbook for the course NA311 - Analysis of Naval Tactics. The book is also a unique reference for the underlying theory of prevailing probability models for several naval tactical scenarios, many of which are addressed topically only in fleet tactical publications.

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PRESENTATIONS

APPLIED SCIENCE DEPARTMENT

MONTOR, Karel, Associate Professor, "Fourier Analysis of Brain Waves,"  
13th Annual Meeting of the American Association for Medical Instrumentation, 31 March 1978.

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MONTOR, Karel, Associate Professor, "Brain Wave and Biochemical Research Findings," 3rd Annual Meeting of the Association for the Role of Behavioral Science in Physical Security, 3 May 1978.

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MYLANDER, W. Charles, Associate Professor, "Using PIES to Answer Questions About the U. S. Energy Future," Northeast AIDS Conference, Washington, D. C., 1-2 June 1978.

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MYLANDER, W. Charles, Associate Professor, "Matrix Generator Languages vs FORTRAN," ORSA/TIMS Meeting, Atlanta, Georgia, November 1977.

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## CHEMISTRY DEPARTMENT

*Professor Samuel P. Massie, Chairman*

Research in the Chemistry Department is a vital part of the program to provide the best possible education for the midshipmen. It serves to expose faculty and student alike to applied problems of naval interest and to offer an opportunity to apply classroom concepts in search of new answers.

The nature and extent of that involvement by faculty and students is indicated by the following: 14 of our faculty, military and civilian alike, and 10 students are among the names that follow. The studies have dealt with new educational techniques and media (5), environmental effects on metals, fuels and propellants (6), biochemically and medicinally related topics (5), theoretical calculations (2), synthetic problems (3), biological relations (2), and technical evaluation of potential military systems (2).

Research support has come from the Naval Academy Research Council and David W. Taylor Naval Ship Research and Development Center among others.

The usual breadth of interest that is characteristic of chemistry is reflected in the listing that follows. The mixture of elegant but significant basic research and that of a more applied flavor has exposed our midshipmen to a fine balance in service of the education of naval officers.

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## METAL PARTICIPATION IN METALLOCENE CHEMISTRY

Researcher: Lieutenant Thomas E. Bitterwolf, USN

Sponsor: Naval Academy Research Council

Metallocene compounds of the iron group elements have been studied as unique organic systems for several years and a detailed and varied synthetic chemistry has evolved. Little of this research has been focused on the participation of the metal in the chemistry of this class.

The research now underway is exploring two aspects of the metal participation question as they relate to ferrocene.

First, does the metal serve as an initial point of attack in electrophilic exchange reactions? For the specific case of the hydrogen exchange reaction, the metal does seem to be the initial site and an examination of the structure and chemistry of this intermediate is being conducted. This is accomplished by examining a variety of substituted ferrocenes in very strong acid using NMR as a structural probe.

Second, it is known that metals can stabilize carbenium ions but the structure of the resulting ions and the degree of direct metal involvement is still confused. An examination of substituted ferrocenyl carbenium ions using the NMR should shed light on this question.

As the two aspects of this project deal with the configurations of ferrocenyl systems, they seem to support each other. Specifically, structural interpretation in one series clarifies evidence in the other.

In support of these goals is an active synthetic program using literature methods or original preparations to obtain a library of useful compounds.

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## COMPUTER-AUGMENTED VIDEO EDUCATION IN CHEMISTRY: LABORATORY EXERCISES

Researcher: Associate Professor Frank J. Gomba

Sponsor: Naval Academy (Academic Dean)

This was a computer-augmented video education project (CAVE) which utilized both computer and ETV programs. The project had a three-fold purpose: (1) to provide pre-laboratory instruction, emphasizing correct laboratory procedure and data collection via video programs; (2) to provide drill on data treatment, both visually via ETV and by computer presentation; and (3) to provide realistic, but randomly created, data that could

be collected during an experiment by means of a computer program. If a midshipman missed a laboratory experiment this could be used along with the ETV segment to provide a laboratory experience in a remote manner. Preliminary evaluation has shown that the midshipmen using one of the two programs developed, received an average mark of 94.5% while those not using the program received an average mark of 81.0%. In addition, a laboratory related program was answered correctly by 70% of the midshipmen using the program vs 60% by those not using the program.

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## THE PH-DEPENDENCE OF THE OXIDATION OF OXYHEMOGLOBIN BY COPPER(II)

Researcher: Lieutenant (junior grade) Linda D. Lauer, USNR

Sponsor: Naval Academy Research Council

Since the effective transport of oxygen by the bloodstream requires that the oxidation of hemoglobin be minimized, it becomes important to understand the mechanisms by which the oxidation reaction occurs. The presence of copper(II) has been implicated in the autoxidation of blood, and it has been shown that significant oxidation of oxyhemoglobin occurs in the presence of high copper(II) concentrations. At low concentrations, however, little oxidation is observed. It has been proposed that this is due to the presence of a high-affinity copper binding site (believed to be a histidine residue) in the hemoglobin molecule. Studies of the reaction between pH values of 6.0 and 8.5 showed that the extent of oxidation of oxyhemoglobin by copper(II) increased drastically as the pH dropped below 7.0. This may reflect a protonation of the copper binding site with a subsequent increase in free copper ion concentration. The presence of histidine at the binding site is strengthened by the observed pH-dependence, since the pKa of histidine residues in proteins normally falls between 5.6 and 7.0.

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## A STUDY OF BASIC MECHANISMS OF BIOLOGICAL-CHEMICAL FILM FORMATIONS AFFECTING THE LEACH RATE OF COPPER COMPOUNDS FROM ANTI-FOULING PAINTS

Researcher: Professor Samuel P. Massie

Sponsor: David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory

It was shown, using x-ray diffraction, electron microscopy, and/or high magnification color photography, that techniques are available for the chemical analyses of film structures. It was also shown that basic copper chloride and/or basic copper carbonate constituted the chemical

film surfaces, and that diatoms were also present. Leach studies on freshly painted and immersed steel plates showed the presence of copper ion and the utility of bathocuproine (suggested by Professor Rollins) as a reagent for small amounts of copper.

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## OPTICAL PROPERTIES OF DIATOMIC MOLECULES

Researcher: Lieutenant Henry E. Montgomery, Jr., USN

Sponsor: Naval Academy Research Council

Variational perturbation theory was used to calculate parallel and perpendicular dynamic dipole polarizabilities, the refractive index, the Rayleigh and Raman scattering cross sections and the Rayleigh and Raman depolarization factors of the hydrogen molecular ion as a function of the frequency of the incident radiation. Exact  $H_2^+$  wavefunctions are used as the zero-order system. The procedure locates the first excitation energy to within  $2 \times 10^{-5}$  hartree and gives satisfactory results well into the first anomalous dispersion region. For internuclear distances near the equilibrium separation, the oscillator strength formulae for polarizabilities together with accurate values for the oscillator strengths of the first parallel and perpendicular transitions yield lower bounds for the dynamic polarizabilities which are in excellent agreement with the results of the variational perturbation calculations.

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## COMPUTER-AUGMENTED VIDEO EDUCATION IN TROUBLESOME AREAS OF CHEMISTRY

Researcher: Assistant Professor John V. Prestia

Sponsor: Naval Academy (Academic Dean)

The use of television and computer to present interactive tutorial material for problem solving in general chemistry was undertaken by producing pilot programs from typically troublesome concepts such as molecular weight, ideal gases, and hydrolysis of salts.

The student proceeds through the self-paced program in four steps: (1) audiovisual presentation of the concept; (2) sample problem presentation; (3) student practice; and (4) interactive assistance sequence. These modules are designed to take one hour and tend to be limited to two or three concepts to allow student practice time.

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## MEASUREMENT AND CONTROL OF REFLECTION OF LIGHT FROM GLASS-REINFORCED PLASTICS SURFACES (BULK OR COATING)

Researcher: Associate Professor Robert R. Ressler

Sponsor: David W. Taylor Research and Development Center,  
Annapolis Laboratory

This project undertook a preliminary survey of the literature dealing with the problem of reflection of light from underwater structures, structures which should be able to escape detection when subjected to surveillance by unfriendly forces. Submarines, in particular, must have their surfaces coated with low-reflectance paints to minimize visibility on the surface or submerged.

The problem of interest was what is done or can be done to control brightness and contrast with the GRP coatings which are coming into widespread use.

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## PHOTOCHEMISTRY OF NITRAMINES

Researcher: Associate Professor Charles F. Rowell

Sponsor: Naval Academy Research Council

The goal of this research was the elucidation of the mechanism of the photodecomposition of nitramines: a common class of military explosives. During this year syntheses of several important intermediates in the proposed decomposition were carried out and the general nature of the products formed during solution irradiation were clarified.

The nature of the photochemical states was also worked out. A few peripheral details need to be clarified but, in general, the mechanism is shown to be: nitramine, to nitroxide, to hydroxylamine and nitron, to oxazirane, to amide and slowly to further amide photochemical cleavage.

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## TAGGING TECHNIQUES AND EVALUATION

Researcher: Associate Professor John W. Schultz

Sponsor: National Security Agency

This was a literature survey and evaluation performed for NSA. The culmination of this work was a written report for NSA. While not classified, the subject matter is proprietary.

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## COMPARISON OF METHODS OF ANALYSIS OF OIL IN SEAWATER

Researcher: Professor John Zimmerman

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

Samples containing two different oils (a lubricating oil and a fuel oil) dispersed in water were analyzed for oil content by three different methods and the results compared. The methods were: (a) a standard method employing IR analysis of a Freon-113 extract of the suspended oil; (b) a similar method (developed at DTNSRDC) using a  $\text{CCl}_4$  extract; (c) a standard gravimetric procedure. The study (which is not complete) determined that the two IR methods are comparable in accuracy and superior to the gravimetric procedure. Differences in oil recovery were small for the two IR methods, but the edge went to the Freon-113 method. Certain improvements in the Freon-113 method involving sample size and shaking times were recommended.

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## MODEL COMPOUNDS FOR STUDYING A MECHANISM FOR THE PHOTOCHEMISTRY OF EXPLOSIVES

Researcher: Midshipman 1/C Scott L. Stafford

Adviser: Associate Professor Charles F. Rowell

Sponsor: Trident Scholar Program

The purpose of this work was to synthesize and photolyse model compounds that will provide isolable products similar to RDX whose structural features provide no hope of such isolation.

N-nitropiperidine (1) and 1,4-dinitro-1,4-diazacyclohexane (2) were synthesized, purified, and photolyzed under both sensitized and unsensitized conditions. Products were isolated and examined by ir, nmr and molecular weight determinations.

Photolysis of the indicated product (1), 2-piperidone, in the presence of  $\text{NO}$  and under a stream of nitrogen showed results in keeping with the products from the nitramine photolyses, i.e., some Norrish Type I and II cleavage.

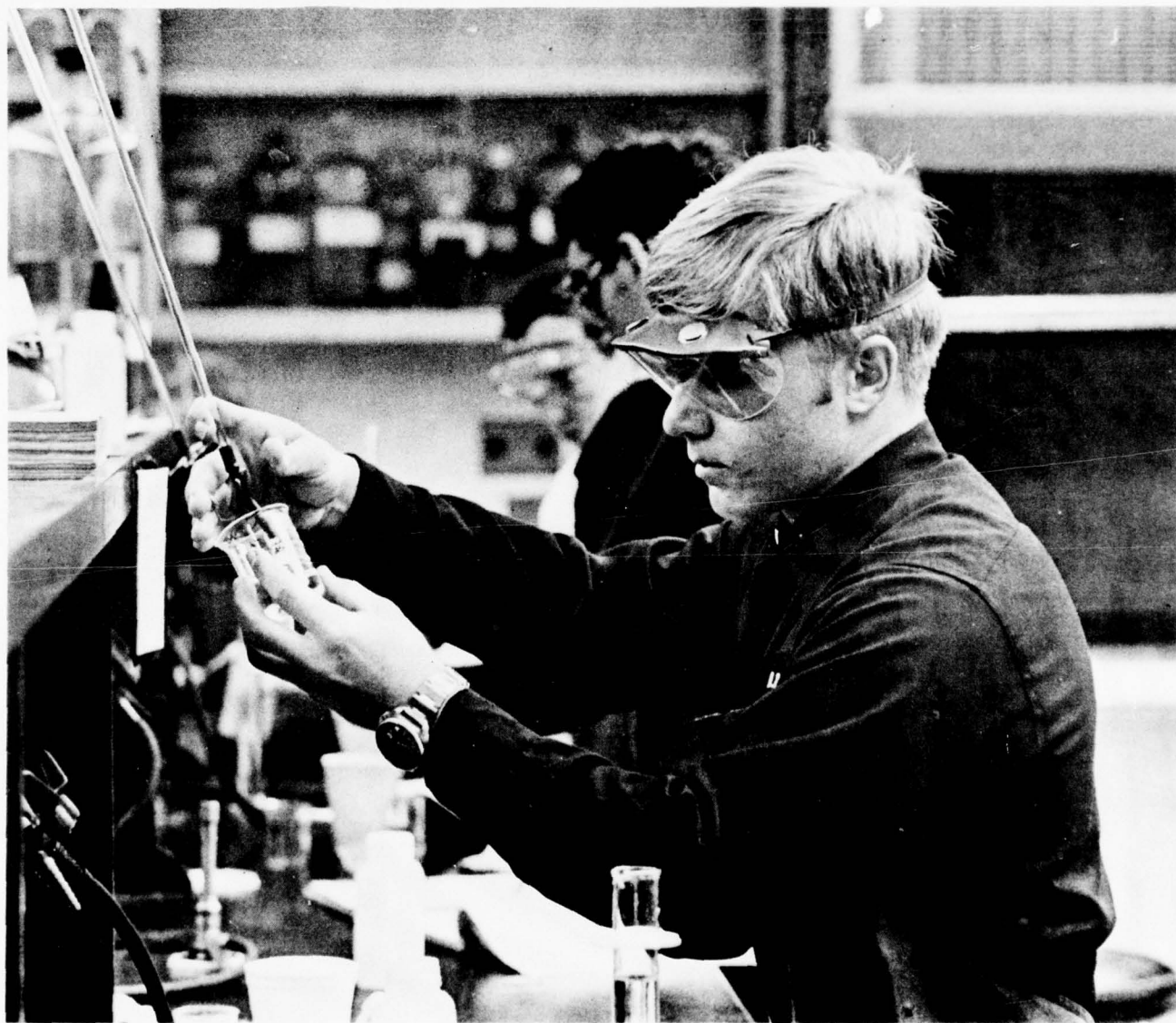
Preparation of 1,3-dinitro-1,3-diazacyclohexane by literature methods failed in our hands.

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DEVELOPMENT OF UNIT SENSITIVE TUTORIAL PROGRAMS FOR GENERAL CHEMISTRY

Researcher: Professor Don G. Sheets

A computer sub-program has been developed which is capable of performing mathematical operations on units along with numbers. The result of each operation is printed as a number followed by the appropriate combination of unit abbreviations, each raised to the appropriate power. Short modules which randomly generate practice problems on specific topics have been written to be used with the sub-program above to give midshipmen computer-assisted instruction in general chemistry.



## THE SYNTHESIS OF NITROGEN MUSTARD DERIVATIVES OF HYDANTOINS AS ANTI-BRAIN-TUMOR AGENTS

Researchers: Midshipmen I/C Carl J. Garvin and Charles G. Nickell

Adviser: Professor Samuel P. Massie

Potential synthetic routes for the title compounds were studied with the goal of controlled synthesis in acceptable yields. The processes studied were found to have shortcomings in approaching the desired goals.

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## PHOTOCHEMISTRY OF N-NITROPYROLLIDINE

Researcher: Midshipman I/C Thomas Hovatter

Adviser: Associate Professor Charles F. Rowell

It was the purpose of this research to photolyse N-nitropyrollidine in solvents that foster singlet formation and in solvents that contain triplet sensitizers in order to compare the products under these two sets of conditions.

Samples of the nitramine were photolysed by a medium pressure Hg arc in solutions with the hexane as solvent and with hexane containing 1 percent benzophenone. After the solvent had been removed in each case, the residue was chromatographed on a alumina column and the fractions were analyzed by ir, nmr, and vapor pressure osmometry.

All products separated were found to be amides with somewhat higher molecular weight than those predicted for the simple degradation of the nitramine. Norrish Type I and II photocleavage of the product from the initial photolysis found support in some of the nmr spectra.

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## THE OXIDATION OF OXYHEMOGLOBIN BY COPPER (II) OF PHYSIOLOGICAL PH

Researcher: Midshipman I/C Robert Laughlin

Adviser: Lieutenant (junior grade) Linda D. Lauer, USNR

Trace amounts of copper(II) have been implicated in the autoxidation of human hemoglobin in the red blood cell. The rate of oxidation of adult human oxyhemoglobin by varying amounts of copper(II) was examined spectrophotometrically at physiological pH. Incomplete results indicated that at

the low copper(II) concentrations, very little hemoglobin was oxidized compared to the extent of oxidation at higher copper concentrations. This supports previous work that has suggested that a copper(II)-binding amino acid sidechain is present in the hemoglobin molecule.

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## OPTICAL SCATTERING BY DIATOMIC MOLECULES

Researcher: Midshipman 1/C T. G. Rubenstein

Adviser: Lieutenant Henry E. Montgomery, Jr., USN

Analysis of the scattering of light by diatomic molecules requires accurate determination of the frequency-dependent parallel and perpendicular dipole polarizabilities and their derivatives with respect to the internuclear separation. Time-dependent variational perturbation theory was used to calculate polarizabilities over a range of internuclear separations bracketing the potential minimum. The polarizability data was fitted by a Chebyshev polynomial expansion which was then used to calculate derivatives. The wavelength range from 4000 to 6000 angstroms was extensively studied since experimental work in this region has been proposed.

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## PROPERTIES OF HYDROXY FERROCENE

Researcher: Midshipman 1/C Frank Schraml

Adviser: Lieutenant Thomas Bitterwolf, USN

Hydroxy ferrocene is unique in that it is an air-sensitive member of an otherwise air-stable family of compounds. This feature suggests that the compound might exhibit internal isomerization to a metal hydride for which air sensitivity has been demonstrated. To study this possibility, it was proposed that hydroxy ferrocene be prepared under rigidly air-free conditions and that its IR and NMR spectra be examined for evidence of a metal hydride bond.

Synthesis of this compound proceeds through several precursors including lithioferrocene, ferrocenyl boronic acid, and ferrocenyl acetate. These precursors are all water sensitive and require stringent conditions.

Preparation problems in the syntheses of the precursors have been overcome and preparation of the hydroxy ferrocene is proceeding apace.

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## SYNTHESIS OF ACRIDINE CARBINOL AMINES AS POTENTIAL ANTIMALARIALS

Researcher: Midshipman 1/C Thomas W. Whitehouse

Adviser: Professor Samuel P. Massie

Potential synthetic routes to the class of compounds in the title were probed. Several were found unsuccessful due to low yields or predominance of undesired by-products.

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## NEW UNDECATUNGSTROGALLATES (III)

Researchers: Midshipmen 1/C Thomas W. Whitehouse and Frank V. Schraml

Adviser: Professor Orville W. Rollins

A new undecatungstate anion containing both gallium and aluminum atoms was synthesized, analyzed to establish its empirical formula, titrated in its acid form to determine its molecular formula, and had its structure determined by x-ray crystallography.

The special nature of this anion arises from its containing both gallium and aluminum ions and its charge of negative 8. The compound  $[\text{GaO}_4\text{AlO}_6\text{W}_{11}\text{O}_{30}]^{8-}$  is a member of the Keggin-type anions as measured by x-ray and other data.

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## THE PH-DEPENDENCE OF THE OXIDATION OF CARBOXYHEMOGLOBIN BY COPPER(II)

Researcher: Midshipman 1/C C. S. Willson

Adviser: Lieutenant (junior grade) Linda D. Lauer, USNR

The oxidation of oxyhemoglobin by copper(II) has been shown to be dependent upon the pH of the solution. However, the role of copper in the reaction is unknown, and it is possible that this observation simply reflects the pH-dependence of the reaction of free molecular oxygen with the ferroporphyrin group of hemoglobin. The extent of oxidation of carboxyhemoglobin by copper(II) was examined spectrophotometrically at pH values of 6.5 to 8.0. As in the case of oxyhemoglobin, the extent of oxidation increased drastically as the pH dropped below 7.0. This similarity of behavior suggests that the same mechanism is operative in each case, and that the oxidation of oxyhemoglobin is not due solely to a reaction with dissociated molecular oxygen.

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BITTERWOLF, Thomas E., Lieutenant, USN, co-author, "Metallocene Basicity IV, Conformational and Electronic Behavior of Some Protonated Ferrocenes," Journal of Organometallic Chemistry, 141 (1977), 355.

Ferrocene has been shown to undergo metal protonation in very strong acids. Upon protonation, the cyclopentadienyl rings of the ferrocene molecule tilt away from the hydrogen introducing ring-ring steric interactions, which in some cases eliminate ring rotation.

1,3 disubstituted ferrocenes were shown to exist as two non inter-connecting rotamers in acid solution demonstrating that the ring rotation can be frozen in either of two ways.

Fluorophenyl ferrocenes were used to determine the Hammett substituent constants for both ferrocene and ferrocenonium.

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KOUBEK, Edward, Professor, and Peter JOHNSTONE, Midshipman 2/C, "A Solvent Extraction Experiment for the Freshman Laboratory," Journal of College Science Teaching, 7 (1978), 1241.

This paper reports the successful results of a study made to improve a long standing student experiment described in the classic text, Experimental Physical Chemistry by Daniels and Alberty. The original experiment used carbon tetrachloride, a toxic solvent, and ether, an inflammable one, as the organic phases and acetic acid as the solute. Substitution of toluene and pentanol reduced the solvent hazard. The use of butyric acid to replace the acetic acid was found to give better data due to the more favorable ratio of solubility. The fact that this solute is also quite cheap is offset somewhat by its odor. Other substitutes such as benzoic acid, and propionic were not found acceptable.

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MONTGOMERY, Henry E., Jr., Lieutenant, USN, "One-Electron Wavefunctions. Accurate Expectation Values," Chemical Physics Letters, 50 (1977), 455-458.

Accurate expectation values for the total energy, the kinetic energy, the potential energy and the quadrupole moment integrals ( $\chi^2$ ) and ( $Z^2$ ) are calculated using the exact wavefunctions for the  $1s\sigma_g$  and  $2p\sigma_u$  states of  $H_2^+$ . A method has been developed to determine which regions of the wavefunction contribute most to a given expectation value.

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MONTGOMERY, Henry E., Jr., Lieutenant, USN, "Helium Revisited. An Introduction to Variational Perturbation Theory," Journal of Chemical Education, 54 (1977), 748-749.

The Schrodinger equation for the helium atom was solved using variational perturbation theory and the Hartree-Fock approximation. This approach was shown to permit rapid calculation of an accurate second-order energy correction. The first-order correction to the wavefunction was shown to result in an increase in the average interelectronic distance thereby making the atom more stable.

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RESSLER, Robert R., Associate Professor, "Measurement and Control of Reflection of Light from Glass-reinforced Plastics Surfaces (Bulk or Coating) - A Literature Search," September 1977.

The report described the preliminary survey of the literature dealing with the problem of reflection of light from underwater structures, structures which should be able to escape detection when subjected to surveillance by unfriendly forces. Submarines, in particular, must have their surfaces coated with low-reflectance paints to minimize visibility on the surface or submerged. The problem of interest was what is done or can be done to control brightness and contrast with the GRP coatings which are coming into widespread use.

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STAFFORD, Scott L., Midshipman 1/C, "Synthesis and Photolysis of Model Compounds for Mechanistic Studies of 1, 3, 5-Trinitro-1,3,5-Triazacyclohexane (RDX) Decomposition," Trident Scholar Project Report Number 96 (1978), U. S. Naval Academy, Annapolis.

This work studied the photochemistry of nitramines. Initially, the synthesis of 3 nitramines which have similar properties to 1,3,5-trinitro-1,3,5-triazacyclohexane (RDX) was performed. The 3 compounds are: N-nitropiperidine, N,N-dinitro-piperazine, and 1,3-dinitro-1,3-diazacyclohexane. They were characterized by their infrared and NMR spectra, and by comparison of their physical properties with literature values. The photochemistry of N-nitropiperidine and N-N-dinitropiperazine was conducted in a quartz cell using a Hanovia medium pressure, mercury-arc, immersion lamp (200w).

The functionality of the decomposition products led to the proposal of a mechanism which describes the photochemical decomposition of cyclic nitramines.

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WEINGARTNER, David L., Assistant Professor, "Production and Trophic Ecology of Two Crayfish Species Cohabiting an Indiana Cave," Dissertation Abstracts International, 38 (1978), 4626-B.

Two species of crayfish cohabiting a stream of an Indiana cave were studied. One species is an obligate cavernicole highly adapted to the cave environment. The other crayfish maintains a population not only in the cave, but also in a surface stream; it is considered a facultative cavernicole.

The goal of the study was to determine the responses of these two species to a habitat having an extremely low food input. This was accomplished by tracing the flow of energy into the cave and through the crayfish populations, and by comparing the results to energy flow in the surface population. This involved determining the qualitative and quantitative nature of the food base, the qualitative and quantitative nature of the crayfish diets, and how ingested energy was utilized by the two species.

It was found that the cave habitat affected partitioning of the crayfish energy budgets and that the obligate cavernicole had the most highly modified energy pattern, which seemed directed towards energy conservation.

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PRESENTATIONS

CHEMISTRY DEPARTMENT

COREY, R. Reece, Professor, "Enteric Bacteria of Sea Gull Feces."  
Maryland Consortium of Biological Scientists, Towson, Maryland,  
29 April 1978.

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GOMBA, Frank J., Associate Professor, "Computer-Augmented Video Education  
in Chemistry: Laboratory Exercises." Ninth Annual Conference on  
Computers in Undergraduate Education, Denver, Colorado, 12-15 June 1978.

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JOHNSTONE, Peter, Midshipman 2/C, "Development of a Solvent Extraction  
Experiment for the Freshman Laboratory." 1978 Intercollegiate Student  
Chemists Conference, Newark, Delaware, 22 April 1978.

\*\*\*\*\*

MASSIE, Samuel P., Professor, "St. Elmo Brady, the First Black Chemist  
Awarded a Doctorate." Afro-American Historical Society, Washington, D.C.,  
October 1977.

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MASSIE, Samuel P., Professor, "From Carver to Hill, And On." American  
Association for the Advancement of Science, Washington, D. C.,  
February 1978.

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MONTGOMERY, Henry E., Jr., Lieutenant, USN, "Optical Properties of the  
Hydrogen Molecular Ion." 175th American Chemical Society National  
Meeting, Anaheim, California, 12-17 March 1978.

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MONTGOMERY, Henry E., Jr., Lieutenant, USN, co-author, "An Electrodynamic  
View of Long-Range Interactions." 12th Middle Atlantic Regional  
American Chemical Society Meeting, Hunt Valley, Maryland, 5-7 April 1978.

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PRESTIA, John V., Assistant Professor, "Computer-Augmented Video Education  
(CAVE) in Troublesome Areas of Chemistry." Ninth Annual Conference on  
Computers in Undergraduate Curricula, Denver, Colorado, 12-15 June 1978.

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PRESENTATIONS

CHEMISTRY DEPARTMENT

STAFFORD, Scott L., Midshipman 1/C, "Model Compounds for Studying a Mechanism of the Photochemistry of RDX." 1978 Intercollegiate Student Chemists Conference, Newark, Delaware, 22 April 1978.

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WEINGARTNER, David L., Assistant Professor, "Production and Trophic Ecology of Cave Crayfish." Maryland Consortium of Biological Scientists, Towson, Maryland, 29 April 1978.





ADVANCED  
CALCULUS  
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## MATHEMATICS DEPARTMENT

*Professor Theodore J. Benac, Chairman*

Research has become an integral part of the professional activities of the Mathematics Department. Areas of research reflect the wide range of interest present in the staff. Present activity includes research in algebra, graph theory, harmonic functions, shape theory, non-standard analysis, category theory, differential equations, lattice theory, probability and statistics, operator theory, classical analysis, and differential geometry. A number of research projects have received support from the Naval Academy Research Council.

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## ON THE RIGIDITY OF ALGEBRAS

Researcher: Assistant Professor Jane P. Coffee

Sponsor: Naval Academy Research Council

The object of this research is to prove that a graded algebra which is rigid in its operational structure must also be rigid in its filtration structure. The following theorem has been proved and submitted for publication: If  $A$  is a graded algebra (separated and complete) over a field of characteristic zero and  $A$  is rigid in the category of algebras, then  $A$  is rigid in the category of algebras. Thus  $A$  must be isomorphic, as a filtered algebra, to any  $B$  whose (complete) associated graded algebra is  $A$ . The algebra  $A$  under consideration need not be associative. It is sufficient that  $A$  be an element of a category in which the  $K$ -split extensions of  $A$  by  $A$  considered as an  $A$ -bimodule form a group. The list of such categories includes associative, Lie commutative associative and nilpotent associative. The restriction that the graded algebra be an algebra over a field of characteristic zero is required for the given proof. The result that in a trivial deformation the infinitesimal of the deformation is a coboundary is critical to the proof and this result does not hold for algebras defined over a field of characteristic  $p$ . An alternate proof free of this restriction is the subject of current research.

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## INTERPOLATION AND APPROXIMATION TO SOLUTIONS OF ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS

Researcher: Assistant Professor Allan J. Fryant

Sponsor: Naval Academy Research Council

The objective of this project is to develop, for certain classes of elliptic partial differential equations, approximation theoretic results analogous to those found in classical complex analysis. Such results are obtained using Bergman- or Gilbert-type integral operators which transform analytic functions to solutions of respective differential equations. Using such an approach, analogs of Runge's theorem are obtained for symmetric potential equations, and the symmetric Helmholtz equation. Approximants in such theorems are shown to converge uniformly at a geometric rate. The growth of entire solutions of the bi-axially symmetric potential equation is investigated, and application is made to generating (constructing) complete sequences of solutions from single entire solutions. In addition, the relation of boundary continuity of solutions to the partial differential equations under consideration and that of the solution's analytic associate is investigated. This study has led to the extension of Privaloff's theorem to ultraspherical expansions on a disk.

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THE ASYMPTOTIC BEHAVIOR OF NORMS OF POWERS OF ABSOLUTELY-CONVERGENT  
FOURIER SERIES

Researcher: Assistant Professor Charles H. Heiberg

Sponsor: Naval Academy Research Council

For any function  $f$  of several variables and having an absolutely convergent Fourier series, let the norm of  $f$  equal the sum of absolute values of the Fourier coefficients of  $f$ . The purpose of this project is to investigate the behavior of the norm of  $f^k$  as  $k$  tends to infinity.

Problem 1. Find necessary and/or sufficient conditions in order that the norm of  $f^k$  remains bounded as  $k$  tends to infinity.

Problem 2. Find a sequence  $F_k$  such that the norm of  $f^k$  is asymptotic to  $F_k$  as  $k$  tends to infinity.

Investigations of these problems have been fruitful only if it is assumed that the Taylor development of  $f$  about each absolute maximum of  $f$  satisfies conditions sufficiently strong to insure that each absolute maximum of  $f$  is a strict maximum. Thus, the strength of these sufficient conditions has been a limiting factor on the results obtained and weaker sufficient conditions would result in the solution of problems 1 and 2 for a larger class of functions.

Weaker sufficient conditions have been found, and results on problem 2 are currently being developed. As a by-product of the investigation of the nature of maxima for functions of several variables, results are also being obtained concerning the nature of level surfaces of a real polynomial in several variables with specific applications to equipotential surfaces of axisymmetric harmonic polynomials in three variables.

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## APPLICATIONS OF PSEUDOTOPOLOGICAL COMPACTIFICATIONS

Researcher: Assistant Professor Robert A. Herrmann

Sponsor: Naval Academy Research Council

This is a continuation of the previous Naval Academy Research Council project which resulted in one published manuscript, three papers accepted for publication and three papers submitted for publication. The following problems will be studied: (1) conditions under which the operator on a pseudotopological (semi) group is extendible to various compactifications previously obtained; (2) the completeness of such compactifications;

(3) conditions under which continuous homomorphisms can be extended to the maximum compactifications; and (4) applications of these results to the theory of integration as well as differentiation for such structures.

The investigations use the methods of nonstandard topology with respect to the enlarged model even though all the final results will be translated into convergence space terminology. In particular, for the pseudotopological space, the theory of the  $q$ -monad and the investigator's simple and special extension theory and the theory of nonstandard semi-uniform spaces will be used; for pretopological spaces, the investigator's  $\text{th}$ -monad theory; for specific applications, the  $\theta$  and  $\alpha$ -monad theory.

Results thus far obtained indicate that the pseudotopological space is indeed the most appropriate convergence space for extension theory. For example, it has been shown that if  $f$  is an admissible continuous map from  $X$  to  $Y$  such that  $X$  is open in the discrete extension  $Z$  and  $Y$  is pseudotopological, then there exists a continuous extension  $F$  of  $f$  from  $(Z, q)$  to  $(Y, p)$ . Moreover admissibility is a necessary condition.

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#### DEFORMATION OF MINIMAL SUBMANIFOLDS OF RIEMANNIAN MANIFOLDS

Researcher: Assistant Professor Dominic S. P. Leung

Sponsor: Naval Academy Research Council

Let  $X$  be a transversal Jacobi field on a geodesic  $G$  of a Riemannian manifold  $M$ .  $X$  is said to be integrable if it is the deformation vector field of a one-parameter family of geodesics. It is the first goal of this research project to investigate the necessary and sufficient conditions for a Jacobi field on a closed geodesic to be integrable.

In earlier research, it has been shown that not all Jacobi fields on geodesics are integrable. However, recently many examples of Riemannian manifolds, for which all Jacobi fields on their closed geodesics are integrable, have been found. These examples shed some light on the appropriate necessary and sufficient conditions on the integrability of Jacobi fields on closed geodesics.

It is proposed to carry out the investigation using Hilbert manifold-techniques. The set of all closed curves of  $M$  can be given the structure of a Hilbert manifold  $H$  with a natural Riemannian structure induced by that of  $M$ . The energy function on closed curves of the  $M$  then gives rise to a differentiable function  $E$  on  $H$ . The closed geodesics on  $M$  then correspond to the critical points of the function  $E$  on  $H$ . The problem is now reduced to one of investigating the structure of the critical points of the function  $H$ .

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## TIME-DEPENDENT WAVE MOTION IN THREE SPACE

Researcher: Associate Professor Peter A. McCoy

Sponsor: Naval Academy Research Council

The purpose of this research is to study time-dependent wave motions by integral transform methods. An invertible integral operator whose kernel is the theta function is developed which represents an axisymmetric time-dependent waves in 3-space as the transform of a time-independent waves in 3-space (axisymmetric potentials, ASP). Those ASP that are regular on a sphere and continuous on its closure are studied as a function of the Chebyshev approximation of their boundary values on the sphere over classes of harmonic polynomials. These errors define necessary and sufficient conditions for the ASP to have no finite singularities and are used to determine growth properties. The results extend to generalized biaxymmetric potentials. Chebyshev approximation over classes of Newtonian potentials determines necessary and sufficient conditions for the harmonic continuation of an ASP from a closed sphere of regularity to a (larger) sphere of specified radius to contain a precise number of singularities. The Method of Ascent extends these results to systems of elliptic equations with entire function coefficients. The time-independent conically symmetric wave-equation is reduced under a change of dependent variable to an elliptic equation on a disk. The Dirichlet problem is solved constructively for boundary data assigned on measurable sets. Current research involves construction of solutions to elliptic systems from the means of their boundary values and extension of the above to time dependent waves.

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## SEMINORMAL OPERATORS AND PERTURBATIONS

Researcher: Assistant Professor Donald D. Rogers

Sponsor: Naval Academy Research Council

A (bounded, linear) operator  $T$  on a complex Hilbert space  $H$  is called hyponormal in case its self-commutator  $T^*T - TT^*$  is positive semi-definite, and  $T$  is called cohyponormal in case  $T^*$  is hyponormal. If  $T$  is hyponormal or cohyponormal, then  $T$  is called seminormal.

Seminormal operators have been the subject of intense study in recent years, although a detailed general theory has not been constructed, except for normal operators. A problem that can be studied involves approximating a given operator (in the operator norm) by sets of normal or seminormal operators. This involves fixing a set of normal or seminormal operators (such as by requiring that their spectra lie in a fixed set of complex numbers, or by requiring that they be of the form normal and compact), determining the distance from this set to an arbitrary operator and whether this distance is attained.

Another area of study concerns the existence of invariant subspaces for seminormal operators. This problem is unsolved at present, although recent work of Scott Brown may lead to its solution. The structure of the lattice of invariant subspaces is an area where many open questions remain.

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#### WHITEHEAD THEOREM IN CG-SHAPE

Researcher: Assistant Professor Thomas J. Sanders

Sponsor: Naval Academy Research Council

The objective of this study is to develop an analogue of a classical theorem of J. H. C. Whitehead in compactly-generated shape theory. This should yield useful information about the CG-shape of a topological space from information about its shape groups.

This researcher has defined the shape groups, which should be an integral part of a Whitehead-type theorem, and obtained some preliminary results. Further developments are sought based on investigations of M. Moszynska and J. Keesling that relate to the Whitehead Theorem in shape theory, as well as on results of S. Mardesic and J. Dydak.

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#### THE SPECTRUM OF A GRAPH: GRAPHICAL ENUMERATION: RAMSEY THEORY

Researcher: Assistant Professor Allen J. Schwenk

Sponsor: Naval Academy Research Council

Three areas in graph theory are being studied. This effort has already produced seven articles which appeared the past two years and five others accepted for publication.

It is well-known that the number of closed walks of length  $n$  is simply the  $n$ 'th moment of the adjacency matrix. Similar spectral expressions have been found for unrestricted (either open or closed) walks; and also for walks from any specified starting set of points to another set of terminal points. Knowledge of the number of walks in  $G$  has been applied to find the spectrum of the complement of  $G$ . In conclusion, cyclic and dihedral equivalence relations have been defined for closed walks and Burnside's Lemma has been used to enumerate the number of equivalence classes of both types.

The analytic methods of Polya have been used to determine the asymptotic behavior of the expected number of (unlabeled) trees in a random forest of order  $p$ . Our results can be expressed in terms of the radius of convergence of  $t(x)$  which is the ordinary generating function for trees. The result is similar for other species of trees.

Consideration of spectra has led to four variations of the usual vertex-deletion reconstruction conjecture. One is just the standard problem, which, of course, remains unsolved. Another has a positive resolution due to Tutte. The third version has been shown to be non-reconstructible. The fourth variation remains open. Corresponding problems with analogous results have been found for the edge deletion reconstruction conjecture.

Ramsey problems have been examined for each possible variety of graphs and digraphs, with and without loops and multiple edges, and even for networks. In every case, the resulting Ramsey number either failed to exist, or had a trivial value, or equaled the value for the underlying graph or digraph. Thus, there are no interesting Ramsey problems for multigraphs.

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## THE STABILITY OF CNOIDAL-WAVE SOLUTIONS OF THE KORTEWEG-DE VRIES EQUATION

Researcher: Assistant Professor Robert L. Baker

The question at issue in this research is whether the periodic cnoidal-wave solutions of the Korteweg-de Vries equation are stable to small disturbances.

The investigation parallels in its initial aspects the methods of Jeffrey and Kakutani which were used for the solitary-wave solution of the Korteweg-de Vries equation; the later aspects follow Jeffrey and Kakutani in spirit, but numerical rather than analytical techniques are used to obtain solutions to the perturbation equation. For cnoidal waves, the linearized perturbation equation contains coefficients which are periodic in space and contain the perturbation frequency as a parameter. Floquet theory provides a representation for the solution of the perturbation equation, and the boundedness in space of the solution is determined using an independent set of solutions generated numerically over one period. The results for the six cnoidal wavetrains examined are that there is no indication of exponential growth or decay of the perturbations as time increases, thus indicating temporal stability for the initial value problem where the initial data is bounded for all  $x$ .

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## BRANCHING PROCESSES

Researcher: Assistant Professor Michael W. Chamberlain

The area of research is in the field of discrete time-branching processes with time-dependent birth probabilities. The purpose of the research is to answer questions for a certain economic model ("pyramid sales") using some of the more recent theoretical advances in this field. One goal is to complete work on an expository paper which will begin with a totally elementary discussion of the problem and then introduce more complex models and techniques of solution to provide something of interest for everyone from the casual reader to the expert. Another goal is to generalize and develop ideas and techniques generated by the specific problem for a wider range of application.

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## SINGULAR POINTS, DIFFERENTIAL EQUATIONS, AND LAPLACE TRANSFORMS

Researcher: Assistant Professor James M. D'Archangelo

Investigation is being made to see if previous results for differential equations with Laplace-Stieltjes transforms as coefficients might shed light on the following three problems:

1. If a linear ordinary differential equation has coefficients which are power series in  $1/x$  converging for all absolute  $x$  greater than some  $R$ , are there easily stated conditions on the coefficients which will assure the existence of a solution which is also a power series in  $1/x$  convergent for these  $x$ 's? Making the change of variables  $x = e^t$  changes the differential equation into one with Laplace-Stieltjes transforms for coefficients and previous work might apply.
2. How do the solutions of finite-difference-equations with Laplace-transform coefficients behave?
3. Formal-power-series solutions about irregular singular points for linear ordinary differential equations are obtained by transforming the equations into systems of equations whose solutions are Laplace-Stieltjes transforms.

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## FIELD EXTENSIONS AND HIGHER DERIVATIONS

Researcher: Assistant Professor Richard L. Davis

This study is a continuation of the program described in the Summary of Research Activities, Academic Departments, 1976-1977. It focuses on the nature of the field extension  $K/L$  where

$$L = \bigcap \{K^p(k); n = 1, 2, 2, \dots\}$$

for a subfield  $k$  of  $K$ .

Let  $W$  denote the field  $\bigcap K^p(L)$ . It is not difficult to show that if  $K/L$  is arbitrary, then  $W$  is separably algebraically closed in  $K$ . It was found that if  $K/L$  is separable generated, then  $W$  is the algebraic closure of  $L$  in  $K$ . A proof of this, in which  $K/L$  was assumed to be finitely generated, appeared in 1974. If  $K/L$  is separable, the  $W$  is the field of constants of a higher derivation defined in  $K$ .

Examples have been constructed illustrating that  $W$  need not be the algebraic closure of  $L$  in  $K$  if  $K/L$  is separable, and if  $K/L$  is separable and  $W = L$ , then  $K/L$  is not necessarily separably generated.

This study is expected to continue until a complete picture of the tower of fields  $K \supset W \supset k$  is obtained.

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## FREE PRODUCTS OF FINITELY-GENERATED ABELIAN GROUPS

Researcher: Assistant Professor Anthony M. Gaglione

The object of study is a group  $G$  which is a free product of finitely many groups,  $G(i)$ , each of which is a finitely generated abelian group. The researcher has shown that, to study  $G$ , it is sufficient to consider the case where each  $G(i)$  is an elementary abelian  $p$ -group for a fixed prime  $p$ .

For groups  $G$  with this structure the following type of questions are considered:

- (1) Is it possible to decide (and give examples) when the lower central series of  $G$  stops after finitely many steps?
- (2) Is it possible to determine for which primes  $p$  the group  $G$  is residually a  $p$ -group?
- (3) Can restrictions be found on the automorphism group of  $G$ ?
- (4) Consider the maximal metabelian factor group,  $M$ , of the group  $G$ . Will the lower central series of  $M$  terminate with the unit element? Will the factor groups of  $M$  coincide with those of the full group?

By using basic commutator techniques and Lie algebras, some partial results have been established.

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## FUNCTORS FROM COMPACT PAIRS TO BANACH LATTICES

Researcher: Assistant Professor Donald G. Hartig

The analysis previously undertaken involving the functor  $f$  to  $f\#$  will be extended to the target category of Banach Lattices. Fundamental differences in the relevant representation theorems necessitate certain changes in the axiom system. The arguments used to obtain the natural transformation must also be tailored to fit the lattice structure as opposed to the algebraic structure formerly present.

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## RIESZ REPRESENTATION THEOREM

Researcher: Assistant Professor Donald G. Hartig

Since its discovery, the Riesz Representation Theorem has played a fundamental role in Functional Analysis. In this research a novel approach is undertaken with the goal to obtain a "simplified" proof of this theorem. The approach is categorical and is motivated by an interesting argument. Standard measure-theoretic constructions are replaced with elementary properties of the Stone-Cech compactification of a discrete topological space. Naturally, the complete proof must ultimately involve some measure-theoretic concepts but it appears that, under suitable modification of the arguments, the measure theory can be reduced to a bare minimum.

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## THE CRITICAL POINT BEHAVIOR OF SECTIONAL CURVATURE FUNCTIONS OF RIEMANNIAN-CURVATURE TENSORS

Researcher: Assistant Professor Dominic S. P. Leung

Let  $C$  be the space of Riemannian curvature tensors over a finite dimensional Euclidean vector space  $V$ ,  $G$  be the Grassman manifold of 2-dimensional subspaces of  $V$ , and  $s(R)$  be the sectional curvature function of a Riemannian-curvature tensor  $R$  in  $C$ .  $s(R)$  is a function on  $G$ . It is the purpose of this study to investigate the extent to which the critical points and critical values of  $s(R)$  determine  $R$ .

In addition to developing formulas for computing the critical points of the function  $s(R)$ , formulas are also developed for computing the Hessians of  $s(R)$  at its critical points. Among others, the following facts are proved:

(1) There exists an open and dense subset  $W$  of  $C$  such that  $s(R)$  is a Morse-function on  $G$  for all  $R$  in  $W$ .

(2) Let  $R$ , an element of  $C$ , be one whose Weyl tensor is identically zero. Then  $R$  is completely determined by the critical points of  $s(R)$ , as a function on  $G$ , and the value of  $S(R)$  at these points. However, the corresponding assertion does not hold for an arbitrary element  $R$  of  $C$ .

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## PROPERTIES OF GENERALIZED ROBERTSON FUNCTIONS

Researcher: Assistant Professor Edward J. Moulis, Jr.

In a recent paper the researcher introduced generalized Robertson functions, a class of functions analytic in the unit disk which unify several hitherto disparate classes of functions studied recently. Such geometric properties as distortion and rotation bounds and length-area theorems can be investigated using techniques previously applied to a subclass of these functions. These include the use of representation theorems and variational formulae. Bounds on the radius of convexity of this class have already been obtained. Other methods such as the theory of subordination and extreme point theory will also be utilized.

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 $H^p$  SPACES ON POLYDISCS AND SEMIGROUPS

Researcher: Assistant Professor Howard L. Penn

The objective of this work is to investigate the behavior of  $H^p$  functions on the polydisc and on semigroups. There are two directions that the investigation is taking. The first question is whether the property:  $f$  in  $H^p(U^n)$  and  $f \cdot p_n$  dense in  $H^q(U^n)$  where  $p_n$  are the polynomials and  $p < q$ , implies that  $f \cdot p_n$  is dense in  $H^q(U^n)$ . If this is true, it is somewhat surprising because very few properties of  $H^p$  spaces in one variable carry over to several variables.

A second line of investigation is to look at semigroups in the lattice of integer points in the plane, other than the quarter plane. One possible method of proving results is to relate the functions to functions defined in the regular  $H^p$  space by using a map of semigroups.

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## MATRICES OVER COMMUTATIVE RINGS

Researcher: Assistant Professor William P. Wardlaw

Several years ago, the researcher developed a technique for transferring certain results derived under special conditions for matrices and determinants over a field to generalized results valid for matrices and determinants over an arbitrary commutative ring. These techniques have yielded the following theorems:

(1) Let  $A$  be an  $n \times n$  matrix over a commutative ring  $R$ , and  $f$  the characteristic polynomial of  $A$ . Then  $\text{Adj } A = p(A)$ , where  $p$  is the polynomial given by

$$p(x) = (-1)^{n+1}(f(x) - f(0))/x.$$

(2) Let  $A$  be an  $m \times n$  matrix and  $B$  an  $n \times m$  matrix over a commutative ring  $R$  with  $m$  less than or equal to  $n$ . Denote the characteristic polynomial of  $AB$  and  $BA$  by  $g$  and  $h$ , respectively. Then

$$H(x) = x^{n-m} g(x).$$

(3) Let  $A$  and  $B$  be  $n \times n$  matrices over a commutative ring  $R$ . Then

$$\text{Adj}(AB) = (\text{Adj } B)(\text{Adj } A).$$

The latter result was used in conjunction with other techniques to obtain the following characterization of the adjoint of a matrix over a field:

(4) Let  $B$  be an  $n \times n$  matrix over a field  $K$ . Then there is a matrix  $A$  over  $K$  such that  $B = \text{Adj } A$  if and only if  $B = 0$ ,  $B$  has rank 1, or  $B$  has rank  $n$  and  $\det B$  has an  $(n-1)$ st root in  $K$ .

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#### $n$ -ASSOCIATIVE GROUPOIDS

Researcher: Assistant Professor William P. Wardlaw

A groupoid  $G$  (set with binary operation) is  $n$ -associative if the product of any  $n$  elements of  $G$  is independent of the way in which the factors are associated. In 1970, the researcher proved the following:

**Theorem.** For  $n$  greater than 2  $n$ -associativity implies  $(n + 1)$ -associativity.

This theorem generalizes the generalized associative law and suggests the study of groupoids which are  $n$ -associative but are not  $(n - 1)$ -associative. A number of recent results have been obtained concerning the structure and the possible cardinalities of such groupoids.

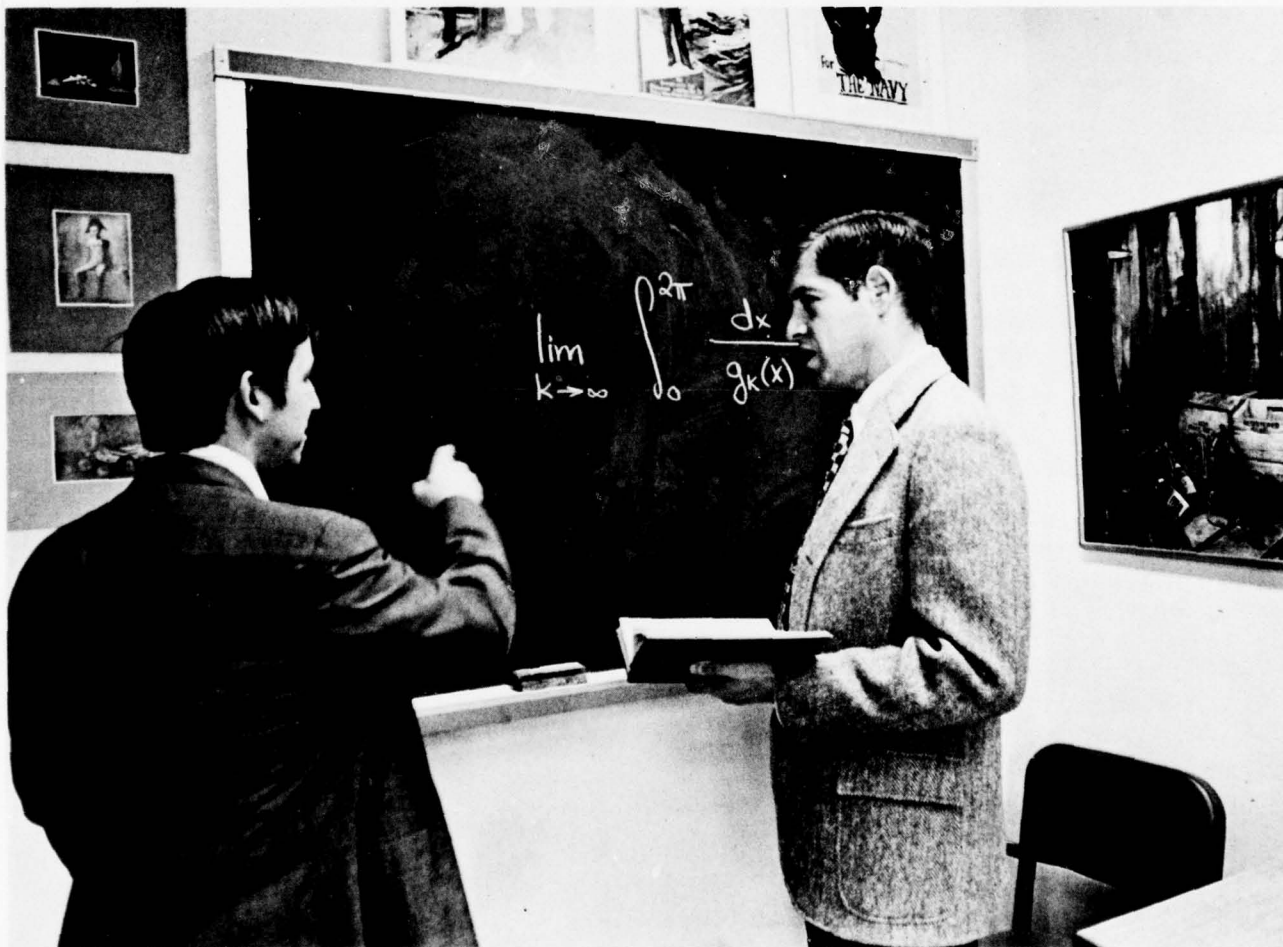
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## RINGS WITHOUT NILPOTENT ELEMENTS

Researcher: Assistant Professor William P. Wardlaw

In 1970, Alexander Abian showed that an order relation which he defined on a commutative ring with no nonzero nilpotent element could be used to find necessary and sufficient conditions that the ring be a direct product of fields. The present research generalized this result to arbitrary (not necessarily commutative) rings without nilpotents. A search of the literature later disclosed that the generalized result had already been published.

Other associated results regarding the structure of rings without nilpotents have been obtained, notably that any finite ring with no nonzero nilpotent elements is a direct product of fields, and is hence necessarily commutative. It is hoped that closer study of the order relations on rings without nilpotents will fill some gaps in the structure theory of rings.



ABBOTT, James C., Professor, Editor, The Chauvenet Papers, A Collection of Prize Winning Expository Papers in Mathematics, Vols. I, II, Mathematical Association of America, 1978.

Since 1925 the Mathematical Association of America has been awarding prizes for outstanding expository papers in mathematics. Twenty-four awards have been made during the fifty year period 1925-1975.

The prize was established to encourage improvement in the teaching of mathematics. The name Chauvenet was selected to honor Professor William Chauvenet for the excellence of his presentations and expositions in mathematics. It is of interest to note that Professor Chauvenet was one of the founders of the U. S. Naval Academy and the first head of its Mathematics Department and that the mathematics wing, Chauvenet Hall, was named in his honor.

In 1975 the Publication Committee of the MAA decided to publish all the prize winning papers in order to make these outstanding papers by the nation's top mathematicians available to teachers and students. Professor Abbott was selected to arrange and edit the series and to write a brief biography of each prize winner. The final result is a two volume collection of past Chauvenet Prize papers currently available through the MAA.

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FRYANT, Allan J., Assistant Professor, "Interpolation and Approximation of Axisymmetric Harmonic Functions," American Journal of Mathematics, 100, (1978), 205-216.

Using a function theoretic approach, harmonic polynomial interpolation and approximation of axisymmetric harmonic functions is considered. The uniform approximation of axisymmetric harmonic functions which are regular on the closure of a region is obtained by harmonic polynomial interpolation at points of the boundary. In the case of the sphere, an Hermite-type formula for the error in approximation by such interpolation is derived, and is used to obtain necessary and sufficient conditions on the choice of interpolation points which insure uniform convergence. For general axiconvex regions, Gilbert's integral operator is used to obtain sufficient conditions on the choice of interpolation points which yield harmonic polynomial interpolants uniformly convergent at a geometric rate.

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GAGLIONE, Anthony M., Assistant Professor, "1978 Summary of Results and Awards," Mathematical Association of America, May 1978.

This summary describes the results and awards from the 1978 Annual High School Mathematics Examination given on 14 March 1978. It is based on reports received at the U. S. Naval Academy (Mathematics Department). Six thousand, three-hundred and forty-two schools and 370,414 students registered for the examination. The mechanical processing and statistical analysis are based on reports from 5,025 schools received at the Naval Academy by the announced deadline.

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HARTIG, Donald G., Assistant Professor, "An Important Functor in Analysis and Topology," American Mathematical Monthly, 85 (1978), 41-43.

Natural properties of the correspondence  $f$  to  $f\#$  which associates to each continuous map  $f$  from  $X$  to  $Y$  ( $X$  and  $Y$  are compact Hausdorff spaces) the operator  $f\#$  from  $C(Y)$  to  $C(X)$  defined by  $f\#(\alpha) = \alpha \circ f$  are discussed. This correspondence is an example of a "functor" which, in general, is a function taking mappings of a certain kind (here continuous functions between topological spaces) to mappings of another "category" (in this case the continuous algebraic homomorphisms between Banach Algebras). The purpose of this article is to point out that the "categorical" approach to a problem offers several advantages. It can often give added insight; it usually provides the proper context in which comparisons with similar problems (and their solutions) can be made; and the general theory usually provides several natural questions that should be resolved.

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HARTIG, Donald G., Assistant Professor, "Local Connectedness and Pseudocompactness in Completely Regular Spaces," Proceedings of the American Mathematical Society, 68 (1978), 117-120.

The properties of local connectedness and pseudocompactness of a completely regular space  $X$  are characterized via algebraic properties of the space  $C(X)$ . These characterizations are then used to prove the (well-known) theorem that  $\beta X$  is locally connected if and only if  $X$  is locally connected and pseudocompact.

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HERRMANN, Robert A., Assistant Professor, "A Nonstandard Generalization for Perfect Maps," Zeitschrift für Mathematische Logik und Grundlagen der Mathematik, 23 (1977), 223-236.

A generalization of Whyburn's "directed towards" concept is proposed and the results for  $\theta$ -perfect maps and the perfect maps of Fomin are investigated for this generalization. As a framework for this investigation, the methods and procedures of nonstandard topology are selected which frequently reveal similarities between concepts not apparent within the standard model. This is reminiscent of Bernstein's approach to D-compact spaces where his basic definitions are within an ultraproduct. This approach not only gives a conceptual consistency with results of Whyburn, Dickman, and Porter but also employs the obvious economy of effort which is inherent within nonstandard topology. Since compactness, closedness, continuity, etc. are primary ingredients for Whyburn's investigation, generalizations are also introduced for these concepts from the nonstandard viewpoint. However, only results which directly effect the primary structures under consideration are presented.

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HERRMANN, Robert A., Assistant Professor, "Nearly-compact Hausdorff Spaces," Glasnik Matematicki, 12 (1977), 125-132.

In this paper, it is shown that each almost-completely-regular space  $(X, \tau)$  can be densely embedded into a nearly-compact space  $(\alpha(X), \alpha(\tau))$  with the following properties: (1) For each nearly-compact Hausdorff space  $(Y, \tau)$  and each continuous [respectively almost-continuous] map  $f$  from  $X$  to  $Y$  there is a unique continuous [respectively almost-continuous] map  $F$  from  $\alpha(X)$  to  $Y$  which extends  $f$ . (2) Any nearly-compact Hausdorff space in which  $X$  is densely embedded and which possesses property (1) is homeomorphic [respectively  $\theta$ -homeomorphic] to  $\alpha(X)$ . (3)  $(\alpha(X), \alpha(\tau))$  is the projective maximum in the class of all nearly-compact Hausdorff spaces in which  $X$  can be densely embedded. (4)  $X$  is  $C^*$ -embedded in  $\alpha(X)$ . An application is given to  $P$ -closed spaces.

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HERRMANN, Robert A., Assistant Professor, "One Point Near-compactifications," Bollettine della Unione Matematica Italiana, 5 (1977), 14-A, 23-33.

D. Carnahan introduced the concept of the  $N$ -closed set and investigated the class of locally nearly-compact spaces. T. Noiri gives further insight into these two structures in two papers. These investigations show that the locally nearly-compact spaces behave in a manner highly analogous to locally compact spaces, with notable exceptions. The major purpose of this investigation is to show that for each locally nearly-compact

topological space  $(X, \tau)$  there exist nearly-compact Hausdorff one-point extensions  $(Y, \tau^*)$  and  $(Y, \tau)$  such that  $(Y, \tau)$  is a projective minimum in a large class of extensions of  $X$ , and  $(Y, \tau^*)$  is almost a projective maximum. These extensions are in many ways analogous to the Alexandroff one-point compactification for a locally compact space. Various results of Carnahan and Noiri are improved by showing that a Hausdorff space is locally compact if and only if it is locally  $H$ -closed and almost-regular. A necessary and sufficient condition for Obreanu's one-point  $H$ -closure  $(X^*, \tau^\#)$  to be isomorphic to  $(Y, \tau^*)$  is also obtained. A basic lemma established in section 3 of this paper shows that every locally nearly-compact space is almost completely regular and consequently can be densely embedded into an almost maximum near compactification which behaves like the Stone compactification for a completely regular space.

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McCOY, Peter A., Associate Professor, co-author, "Level Sets of Polynomials in  $n$ -real Variables," Pacific Journal of Mathematics, 66 (1977), 491-498.

The methods used in studying the zeros of a polynomial in a single complex variable are here adapted to investigating the level surfaces of a real polynomial in  $n$ -space, with respect to their intersection and finite or asymptotic tangency with certain cones. Special attention is given to the equipotential surfaces generated by an axisymmetric harmonic polynomial in 3-space.

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McCOY, Peter A., Associate Professor, "Extremal Properties of Real Axially Symmetric Harmonic Functions in  $E^3$ ," Proceedings of the American Mathematical Society, 67 (December 1977), 248-252.

The set  $H$  consists of all real harmonic functions which are regular in the open unit sphere about the origin in  $E^3$ . On expressing each harmonic function in an appropriate infinite Fourier series, two problems arise concerning  $H$  and subset  $H_*$  whose members have the first  $m + 1$  Fourier coefficients specified: (1) The infimum of each harmonic function is evaluated as the limit of a monotone sequence of eigenvalues of Toeplitz matrices which are evaluated algebraically from the Fourier coefficients. (2) The unique extremal function in the set  $H_*$  and eigenvalue are determined for which the eigenvalue equals the infimum of the extremal function which in turn equals the supremum over set  $H_*$  of the infima of its members. The proofs use the Bergman-Whittaker Integral Operator to transplant the classical Caratheodory - Feger problem that applies to analytic functions of one complex variable.

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MOULIS, Edward J., Assistant Professor, "On the Univalence of a Class of Analytic Functions," Complex Analysis: Proceedings of the S.U.N.Y. Brockport Conference, S. S. Miller, editor, New York: Marcel Dekker, Inc., 1978, pp. 88-94.

We study a class  $V$  of analytic functions which generalize both functions with boundary rotation at most  $K\pi$  in the unit disk  $E$ ,  $K$  greater than 1, and the class of functions  $f(z)$  for which  $zf'(z)$  is  $\alpha$ -spirallike in  $E$ . In a recent paper, Pfaltzgraaf has shown that functions in the latter class are univalent whenever  $\cos \alpha$  is positive and less than or equal to  $1/2$ . We generalize this result by showing that  $f(z)$  in  $V$  is univalent whenever  $\cos \alpha$  is positive and less than or equal to  $1/K$ , and we explore its sharpness. In proving this result we appeal to the ideas associated with linear-invariant families of analytic functions.

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NILES, Nathan O., Associate Professor, Modern Technical Mathematics, Reston Publishing Co. (A Prentice Hall Co.), February 1978.

This textbook gives comprehensive treatment of basic mathematics, ranging from elementary algebra to probability and statistics. Algebra and trigonometry are stressed throughout, utilizing many technical applications. The objective is to provide the student with a good working knowledge of mathematics which is both flexible and practical. To achieve this goal, many common problems are analyzed and skills in computational technique and problem-solving are emphasized. The subject material in the book is organized in a short, to-the-point manner. In general, the text is less formally organized than competing books. This allows great flexibility in its use. The book offers practical technical problems in machinery, construction, surveying, navigation, chemistry, finance, manufacturing, drafting, and various related fields.

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PENN, Howard L., Assistant Professor, "Inner-Outer Factorization of Functions Whose Fourier Series Vanish Off a Semigroup," Pacific Journal of Mathematics, 69 (1977), 501-504.

It is known that a function which is in the  $H^p$  space on the polydisc if and only if its logarithm has a Fourier series with coefficients that vanish off a certain set. The standard proof uses analytic-function theory. This paper extends the result to  $H^p$  spaces defined on a large class of semigroups. Because the standard proof is not applicable in this setting, a new approach was needed.

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PENN, Howard L., Assistant Professor, "Sweeping Measures From the Polydisc to the Torus," Rocky Mountain Journal of Mathematics, (1977), 117-121.

It is known that if  $\mu$  is a measure defined on the  $n$ -dimensional polydisc, then there is a measure,  $\sigma$ , defined on the  $n$ -dimensional torus so that for any function,  $f$ , in the polydisc algebra, the integral of  $f$  with respect to  $\mu$  over the polydisc is equal to the integral of  $f$  with respect to  $\sigma$  over the torus. This paper gives a constructive method of finding the measure  $\sigma$ , making it easier to know the properties of  $\sigma$ .

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ROGERS, Donald D., Assistant Professor, "Approximation by Unitary and Essentially Unitary Operators," Acta Scientiarum Mathematicarum (Szeged), 39 (1977), 141-151.

This paper continues the study of unitary approximation and some related problems. The distance (in the operator norm) from an arbitrary operator on a separable infinite-dimensional Hilbert space to the set of unitary operators is determined in terms of familiar operator parameters. A nearest unitary operator can fail to exist; this existence problem is solved completely for weighted shifts and compact operators. Analogous problems are considered for approximation by two classes of essentially unitary operators; in these cases it is shown that every operator has a nearest point from these sets.

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ROGERS, Donald D., Assistant Professor, co-author, "Normal Dilations and Operator Approximations," Acta Scientiarum Mathematicarum (Szeged), 39 (1977), 233-243.

This paper refines and extends previous work on operator approximations. Consideration is given to best approximation by self-adjoint operators as well as by non-negative operators. For a given operator the set of such best approximations is convex; broad classes of operators are identified for which each of these sets of best approximations is infinite-dimensional. The work in this paper exploits a fundamental relation between an operator  $T$  and normal dilations of  $T$  with smaller spectra. Known results for the normal dilations may be compressed to give results for the operator  $T$ . Laurent operators and Toeplitz operators are the major classes considered.

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SCHWENK, Allen J., Assistant Professor, "An Asymptotic Evaluation of the Cycle Index of a Symmetric Group," Discrete Math, 18 (1977), 71-78.

Let  $Z(S_n; f(x))$  denote the polynomial obtained from the cycle index of the symmetric group  $Z(S_n)$  by replacing each variable  $s_j$  by  $f(x^j)$ . The limit of  $Z(S_n; f(x))/x^{kn}$  is evaluated as  $n$  increases without bound.

This limit is used to estimate the probability (for  $n$  and  $p$  both large) that a point chosen at random from a random  $p$ -point tree has degree  $n + 1$ . These limiting probabilities are independent of  $p$  and decrease geometrically in  $n$ , contrasting with labeled limiting probabilities of  $1/n!e$ .

In order to prove the main theorem, an appealing generalization of the principle of inclusion and exclusion is presented.

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SCHWENK, Allen J., Assistant Professor, co-author, "Enumeration of Graphs With Signed Points and Lines," J. Graph Theory, 1 (1977), 295-308.

The object is to enumerate graphs in which the points or lines or both are assigned positive or negative signs and treat several associated problems for which these configurations are self-dual with respect to sign change. It is found that solutions to all of these counting problems can be expressed as special cases of one general formula involving the concatenation of a cycle index of the symmetric group with that of its pair group. This counting technique is based on Polya's Enumeration Theorem and the Power Group Enumeration Theorem. Using a computer program, a list is constructed of the number of graphs of each type to twelve points. Sharp asymptotic estimates are also obtained.

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SCHWENK, Allen J., Assistant Professor, "Exactly Thirteen Connected Cubic Graphs Have Integral Spectra," Theory and Applications of Graphs (Y. Alavi et al, editors), Berlin: Springer-Verlag, 1978, pp. 516-533.

This article was inspired by Cvetkovič's attempt to find the connected cubic integral graphs. He had displayed twelve such graphs, and had restricted the remaining possibilities to ninety-five potential spectra. In this article the sole graph omitted from Cvetkovič's list is constructed and it is proved that no other exists.

The thirteenth graph happens to have the same spectrum as one of the others. The cospectral pair confirms a conjecture of Balaban by being indistinguishable under a certain proposed chemical classification scheme.

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SCHWENK, Allen J., Assistant Professor, co-author, "Line Minimal Boolean Forests," Colloq. Math., 37 (1977), 167-173.

The class of graphs in which every nontrivial automorphism has order two is studied. In particular, for each value of  $n$ , the number of edges in a minimal boolean linear forest is determined. The number of distinct forests attaining the minimum is also found.

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SCHWENK, Allen J., Assistant Professor, co-author, "The Number of Self-complementary Achiral Necklaces," J. Graph Theory, 1 (1977), 309-316.

Necklaces with beads of two colors which are left unchanged both by a reflection as well as by the interchange of the two colors are characterized in terms of their axes of symmetry. This characterization is then used to enumerate them.

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WARDLAW, William P., Assistant Professor, "The Game of Googol," The Mathematical Log, 22 (January 1978), 1, 3-4.

This paper gives an analysis of the probabilistic game of Googol. The optimum strategy for playing is developed and the probability of winning calculated, using only mathematics accessible to high school students.

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ABBOTT, James C., Professor, "Implication Algebras," Annual Meeting of the American Mathematical Association of Two-Year Colleges, Atlanta, Georgia, October 1977.

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BAKER, Robert L., Assistant Professor, "LaPlace Transforms and Car-Following Theory," Annual Conference of the American Society for Engineering Education, Vancouver, British Columbia, Canada, 19-22 June 1978.

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FRYANT, Allan J., Assistant Professor, "Extension of Privaloff's Theorem to Ultraspherical Expansions," 753rd Meeting of the American Mathematical Society, Columbus, Ohio, 25 March 1978.

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FRYANT, Allan J., Assistant Professor, "Growth and Complete Sequences of Generalized Bi-axially Symmetric Potentials," 84th Annual Meeting of the American Mathematical Society, Atlanta, Georgia, 6 January 1978.

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HARTIG, Donald G., Assistant Professor, "Functors on Compact Pairs," 84th Annual Meeting of the American Mathematical Society, Atlanta, Georgia, 4 January 1978.

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HERRMANN, Robert A., Assistant Professor, "A Nonstandard Approach to S-closed Spaces," University of Oklahoma Topology Conference, Norman, Oklahoma, 16 March 1978.

\*\*\*\*\*

HERRMANN, Robert A., Assistant Professor, "Generalized Closedness," 84th Annual Meeting of the American Mathematical Society, Atlanta, Georgia, 4 January 1978.

\*\*\*\*\*

McCOY, Peter A., Associate Professor, "Chebyshev Approximation of Axially Symmetric Potentials in 3-space," 81st Annual Summer Meeting of the American Mathematical Society, Seattle, Washington, 17 August 1977.

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McCOY, Peter A., Associate Professor, "HP Solutions of a Class of Second Order Elliptic Equations in the Plane," Northeast Sectional Meeting of the American Mathematical Society, New York, 30 March 1978.

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McCOY, Peter A., Associate Professor, "Polynomial Approximation of Generalized Biaxiallysymmetric Potentials," 84th Annual Meeting of the American Mathematical Society, Atlanta, Georgia, 4 January 1978.

\*\*\*\*\*

MOULIS, Edward J., Assistant Professor, "Coefficients of a Class of Analytic Functions," Regional Meeting of the American Mathematical Society, New York, 30 March 1978.

\*\*\*\*\*

ROGERS, Donald D., Assistant Professor, "Cyclic Vectors and Seminormal Operators," 84th Annual Meeting of the American Mathematical Society, Atlanta, Georgia, 6 January 1978.

\*\*\*\*\*

SANDERS, Thomas J., Assistant Professor, "A Finiteness Condition in CG-shape," Oklahoma Topology Conference, University of Oklahoma, Norman, Oklahoma, 16-18 March 1978.

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SCHWENK, Allen J., Assistant Professor, "The Construction of Cospectral Composite Graphs," Second International Conference on Combinatorial Mathematics, The New York Academy of Sciences, New York, 7 April 1978.

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SCHWENK, Allen J., Assistant Professor, "An Improved Bound for the Classical Ramsey Number  $R(4,4;3)$ ," Special Session on Ramsey Theory, American Mathematical Society Annual Meeting, Atlanta, Georgia, 4 January 1978.

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WARDLAW, William P., Assistant Professor, "A Characterization of the Adjoint," Regional Meeting of the Mathematical Association of America, Petersburg, Virginia, 22 April 1978.

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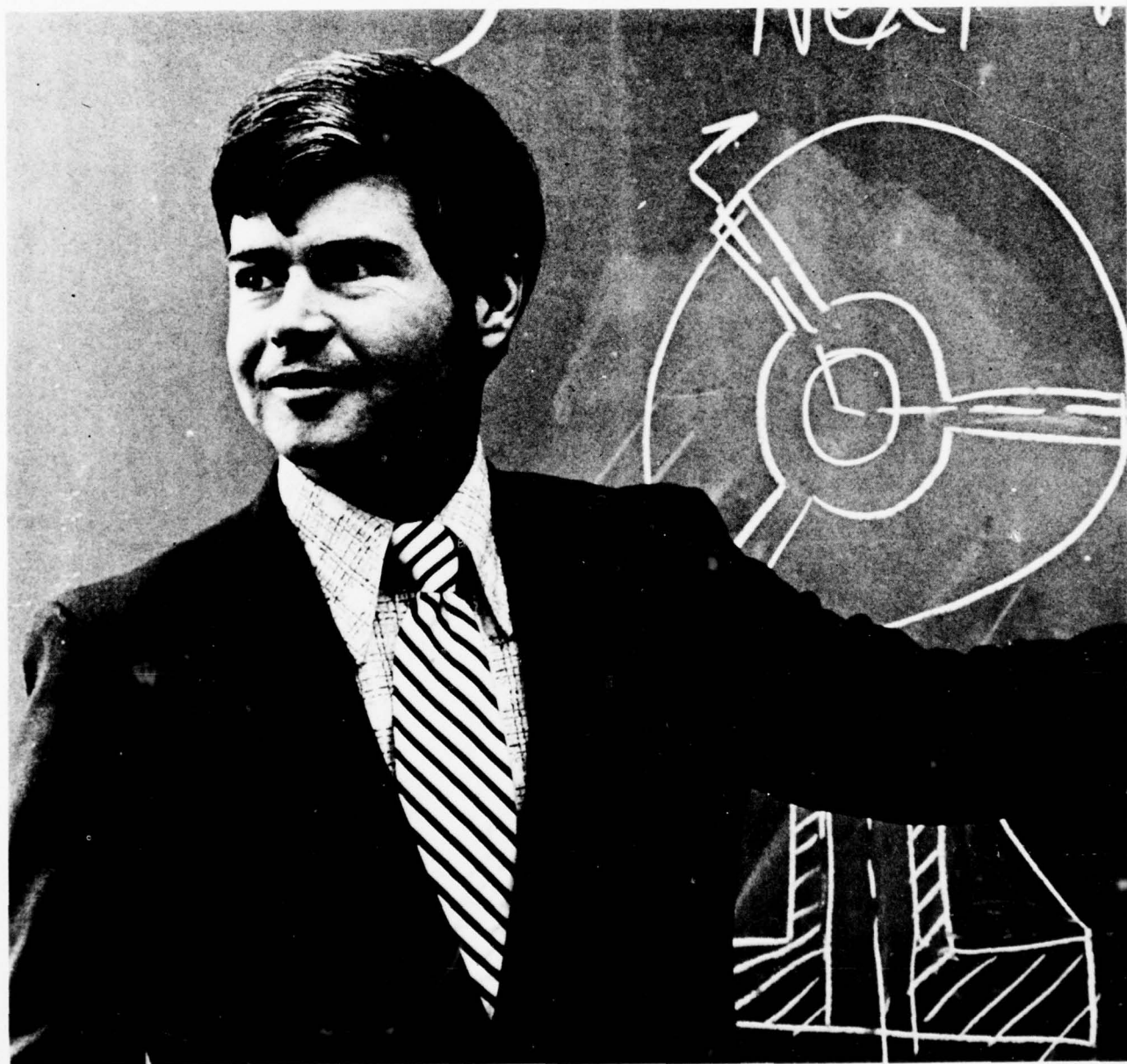
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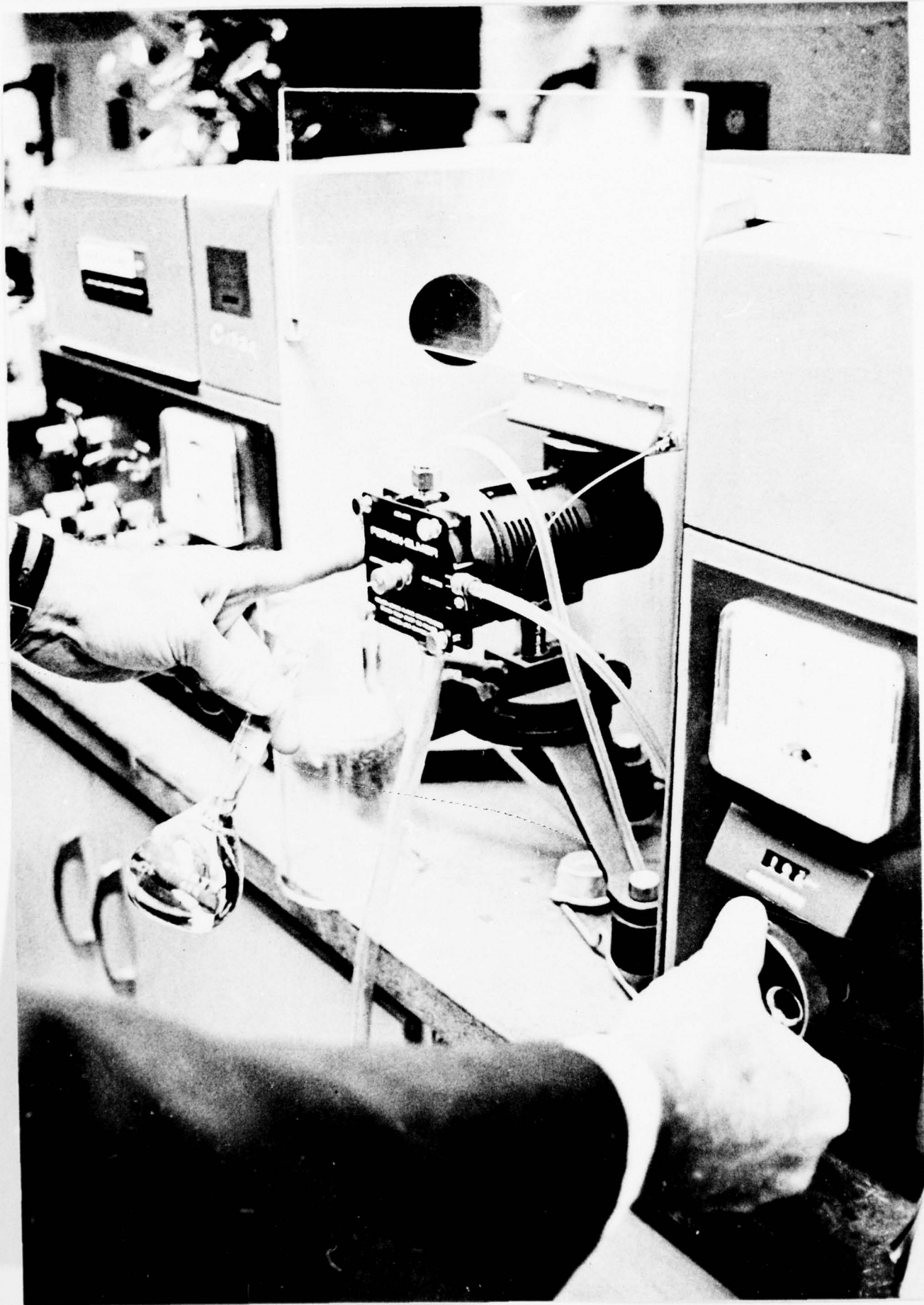
MATHEMATICS DEPARTMENT

WARDLAW, William P., Assistant Professor, "A Transfer Device for Matrix Properties," Regional Meeting of the Mathematical Association of America, Washington, D. C., 19 November 1977.

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WARDLAW, William P., Assistant Professor, "n-Associative Groupoids," 84th Annual Meeting of the American Mathematical Society, Atlanta, Georgia, 5 January 1978.





## OCEANOGRAPHY DEPARTMENT

*Commander John G. McMillan, USN, Chairman*

Research in the Oceanography Department during the 1977-1978 period again covered a wide range of subjects in the environmental sciences. Both the civilian and military faculty were engaged in research projects supported by the Environmental Protection Agency, the Office of Naval Research, the U. S. Army Corps of Engineers, David W. Taylor Naval Ship Research and Development Center, the Naval Academy Research Council, and others. Qualified students were encouraged to undertake research projects as part of their academic programs, particularly in the area of estuarine science, where their data collection efforts could be supported by the Departmental research vessel.

Specific areas of research by the Department included but were not limited to sedimentation processes and properties, submarine geology, oceanic eddy processes, estuarine pollution, estuarine ecology, and marine optics. Many of these efforts involve both faculty and students.

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## AN EVALUATION OF MESOSCALE OCEANIC EDDY STATISTICS

Researcher: Lieutenant Commander H. Lee Dantzler, Jr., USN

Sponsor: Office of Naval Research (Code 481)

This project involves an assessment of North Atlantic eddy variability from historical data and ships-of-opportunity expendable bathythermograph (XBT) and hydrographic data. The historical data analysis consists of: (1) The definition of the long-term mean (over 7 years for the XBT data, >25 years for the hydrographic data) thermal field at selected standard depths in the tropical and subtropical North Atlantic; (2) The mapping of the potential energies associated with vertical displacements from the mean conditions, defined in (1) above, to identify both the areas and magnitudes of that variability; and, (3) The determination of the extent to which the variability in (2) may preclude the use of the local mean temperature-salinity ability correlation to estimate salinities for XBT-provided temperature-depth data from which standard dynamic and sound velocity calculations might be made.

The ships-of-opportunity aspect of this project includes the acquisition of 7 meso-scale samples XBT sections in both data-poor and eddy-active areas. These sections are used to obtain small-wavenumber isotherm displacement spectra for both implied eddy-active and quiescent areas.

Eddy-active areas off the Azores, and within the North Equatorial Current, have been identified for a first time. These areas are imbedded within a broad thermodynamic potential energy maximum surrounding the Subtropical Gyre with the interior of the gyre characterized by a zonal potential energy minimum only partially broken by somewhat higher levels along the flanks of the Mid-Atlantic Ridge.

Local mean temperature-salinity correlations have been determined for much of the North Atlantic. This information extends the utility of the XBT to dynamic and sound velocity calculations, and also serves to help identify anomalous thermal conditions. Salinities are shown to be distributed in a non-Gaussian manner in zones separating different water mass regimes, suggesting that the mean T-S relationship might not be the best measure of central tendency for salinity in those areas. For this case only full T-S-Z data suffice for dynamic or sound velocity calculations.

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## BIOASSAY OF DREDGED SPOIL MATERIALS

Researcher: Assistant Professor John W. Foerster

Sponsor: U. S. Army Corps of Engineers, New York Regional Headquarters

This project was developed to test the feasibility of bioassay procedures implemented under Public Law 92-532 (Marine Protection Research and Sanctuaries Act of 1972). Suggested standard procedures for assaying dredged spoils are being tested as well as procedures for the rearing, handling, and maintenance of test animals and plants. A final objective is providing data on actual test cases supplied by the Army Corps of Engineers from the area surrounding the New York harbor.

In the laboratories of the Oceanography Department (USNA) and the Materials Testing Group (NSRDC/A) assays are made on an alga (Skeletonema costatum).

Dredged materials from areas around New York City are being analyzed using an alga (Skeletonema costatum), a shrimp (Mysidopsus leakia), a clam worm (Nereis virens), a clam (Mercenaria mercenaria), and a fish (Menidia menidia). These bioassay test-organisms are required by the Army Corps of Engineers and the Environmental Protection Agency as representative, sensitive species.

Experimental/analytical procedures follow those outlined in the publication "Ecological Evaluation of Proposed Discharge of Dredged Materials into Ocean Waters," EPA-USACORPS. These are suggested bioassay procedures requiring complicated rearing and application methods. Skeletonema costatum is tested, using the more explicit methods found in the EPA publication, "Marine Algal Assay Procedure."

All results of the 96-hour tolerance bioassays are sent to the Army Corps in New York where they are computerized and analyses made. Major interest is in establishing facilities and expertise to run these studies.

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## ENVIRONMENTAL ASSESSMENT OF SHIP EVALUATION OF OMP-POLYMERS

Researcher: Assistant Professor John W. Foerster

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

An analysis of the chemistry and environmental impact of organo-metallic polymer materials (OMP) was prepared. The project is now complete.

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NUTRIENT AND MICROBIOLOGICAL PROFILING OF SURFACE WATERS IN THE SARGASSO SEA

Researcher: Assistant Professor John W. Foerster

Sponsor: SEA Education Association

A synoptic transect from Cape Cod through the Sargasso Sea to a point 54°W by 22°N and return was made. The purpose was to test the hypothesis that phytoplankton are distributed in patches. These patches coincide with hydrodynamic functions such as Gulf Stream Eddies.

Phytoplankton identification and modeling functions are still to be completed.

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ONSHORE TRANSPORT OF OCEANIC POLLUTION RELATED TO NEARSHORE CIRCULAR CURRENTS ALONG THE EASTERN SEABOARD

Researcher: Professor John F. Hoffman

Sponsor: Naval Academy Research Council

Shoreline features along the coastlines of New Jersey and the Delmarva peninsula indicate that nearshore currents flowing parallel to each of these coasts flow north in the northern portion of the barrier beach and south in the southern portion of the barrier beach. Inasmuch as the flow is a continuum, oceanic water must move westward from offshore toward the beach at some region in between for each beach. This region where the westward movement of oceanic water reaches the coast to supply the northward and southward flow is presently unknown. It is also conceivable that the movement of water may be in a closed circulatory pattern of unknown shape and dimensions. In such a case, pollution at one region of a beach may move seaward and return to another part of the beach.

Evidence of the fact that both northward and southward flow takes place along the coast of each of the above-mentioned barrier beaches is based on the curvature of spits and the deposition of sand behind jetties.

The westward movement of offshore oceanic water may be a mechanism by which waste dumped offshore may move to the shore. One source of such waste may be oil spilled during oil-well drilling, scheduled to commence shortly in the Baltimore Canyon trough offshore of Delaware and New Jersey. The City of Philadelphia presently dumps raw sewerage about 30 miles off-

shore of the Delmarva peninsula. Dupont Chemical dumps acid a similar distance off the same peninsula. An offshore nuclear power plant, to be located about three miles from the barrier beach of New Jersey, is being built for a public utility. The effects on the environment in the Philadelphia and Dupont dump area are being monitored by the Environmental Protection Agency (EPA); however, only minor attempts are being made to trace the shoreward movement of these wastes.

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#### EFFECTS OF FOULING ON THE ACCURACY OF ELECTROMAGNETIC CURRENT METERS

Researcher: Lieutenant Commander J. P. Simpson, USN

Sponsor: Naval Academy Research Council

Ocean current speed-measurements have traditionally been made with mechanical sensors of the savonios rotor (often modified) or propeller type. These mechanical speed-measuring devices all suffer from the same basic weakness - vulnerability (with loss of accuracy) to even mild marine-fouling.

Electromagnetic current meters, however, have no moving parts. The sensor consists of a sphere or cylinder containing an electromagnet and two pairs of external electrodes in contact with the water. Flow around the probe intersects magnetic flux lines causing voltages to be generated which are detected by the electrodes.

Although electromagnetic current meters have been in commercial production for a number of years, there is little information relating the degree of fouling of specific electromagnetic sensors to reduction in accuracy. The National Oceanographic Instrument Test Center (NOIC) conducted a one-month-long experiment in Florida waters several years ago, but the period was not long enough to provide conclusive results. An electromagnetic current meter, calibrated at the Naval Academy's 120' tow tank, has been suspended in the Severn River. The sensor will be withdrawn periodically from the river and tested for accuracy in the tow tank. The tests will continue throughout the spring and summer so that maximum fouling conditions can be observed.

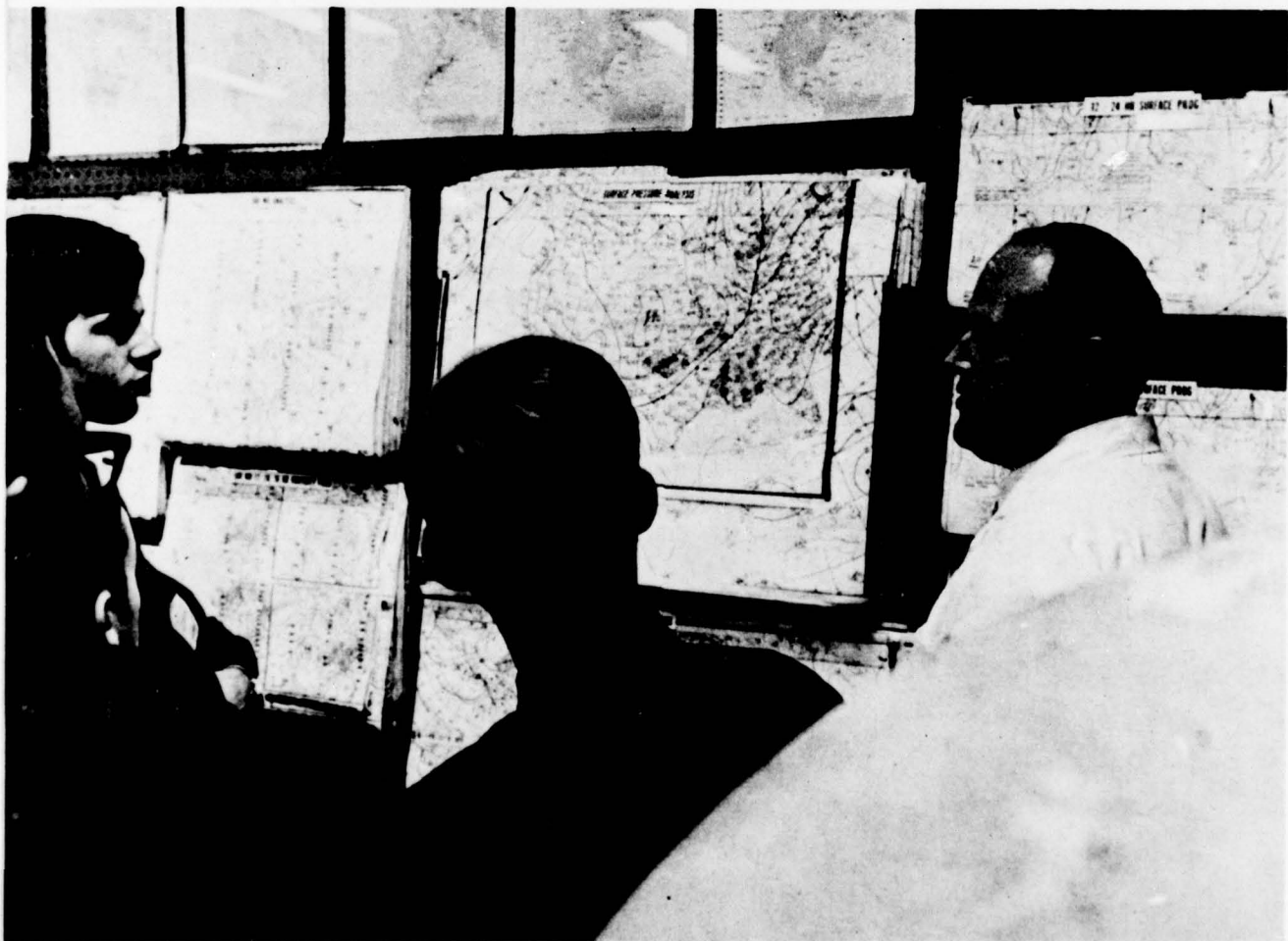
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SUBMARINE CAMOUFLAGE

Researcher: Professor Jerome Williams

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

An analysis of the inherent color properties of oceanic waters was made by converting available data into tri-stimulus coefficients. The objective of this analysis was an attempt to design a paint color that would be close to that of the ocean in both spectral and brightness properties. The result of this analysis indicated that present methods of using flat black with various reflectances could be improved by the utilization of paints having dominant color and reflectance characteristics similar to those of ocean water. These two characteristics were determined for the major portion of the ocean and reflectance vs. wavelength data were prepared for an optimum paint color suitable for use over about 85% of the world oceanic surface area.



OPERATION INTEREST

Researcher: Assistant Professor John W. Foerster

An integrated training experience related to estuaries (INTEREST) was designed to utilize YP654 for non-classroom research. Sections of the Chesapeake Bay were measured for salinity, temperature, depth, phosphates, nitrates, and chlorophyll a. A Tektronix 4051 was interlocked with the salinity-temperature-depth sensing system so that a continuous profile of the sections measured could be recorded for later mathematical modeling. The purpose is to begin a data base for present and future modeling analyses.

All cruising and sampling was performed during 30 May - 1 June 1978. A total of 15 midshipmen participated. The project is half completed.



COMPRESSIBILITY OF SEDIMENTS OF CHESAPEAKE BAY

Researcher: Midshipman 1/C Joseph T. Arcano

Adviser: Professor John F. Hoffman

Recovery of sediments of Chesapeake Bay by coring devices has been consistently less than 100-percent complete. The purpose of this study was to determine the reason. Moisture contents, median grain diameters, organic contents, and diameters of core barrels were examined for 29 core samples obtained from the Severn River and Chesapeake Bay around Annapolis.

It was determined that no close correlation existed between the percentage of recovery of a sample obtained with a gravity core-sampler and the percentage of moisture, percentage of organics, and the median grain size of the sample. Various combinations of individual parameters were also used to form a more complex parameter. Again, no close correlation was evident.

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SHORELINE EROSION ON KENT ISLAND

Researcher: Midshipman 1/C David Buss

Adviser: Associate Professor Douglas W. Edsall

Aerial photographs, for the period 1937-1977, of a portion of Kent Island's shoreline, have been utilized to study the erosional and depositional changes to the shoreline. This data was supplied by the Maryland Department of Natural Resources. The net sediment gain or loss per time interval between aerial photographic surveys has been determined. A phase of accumulation (net) ended in 1947, followed by rather severe net losses until 1969. Since 1969, there has been a slight reversal in the amount of materials lost from the shoreline. However, as of 1977, when comparisons are made with 1937 data, the net loss of sediment from the shoreline is very large. This fact is evidenced by the retreat of the shoreline and inner beach position, as well as the migration of small spits and bars. The major erosional forces are related to tropical storm and northeasterly storm-generated waves. The construction of jetties and bulkheads has apparently stabilized the shoreline in some parts of Kent Island.

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A SPECTRAL DESCRIPTION OF THE SUMMER-TO-FALL TRANSITION IN ATMOSPHERIC PRESSURE PATTERNS

Researcher: Midshipman 1/C Lee D. Delony

Adviser: Lieutenant Commander H. Lee Dantzler, USN

Atmospheric pressure data from the Oceanography Department's meteorological laboratory's microbarograph during the period from June to October 1978 have been analyzed. The data were digitized at hourly intervals, sorted into 1024 hour Summer, and 960 hour Fall sequences, then subjected to a harmonic analysis by a digital Fast Fourier Transform. The spectrum of each record varied as the inverse square of frequency. The summer spectrum displayed periodicities at 9 days (synoptic signal), 24 hours (sea-land breeze pressure cycle), 12 hours (semi-diurnal internal atmospheric tide), and 8 hours (unexplained). The Fall spectrum displayed a larger total variance with significant periodicities at 7 days (synoptic signal) and 12 hours (semi-diurnal atmospheric tide). The results obtained show the spectral manifestations of the increased pressure fluctuations of the Fall storm cycles, and suggest that the sea-land breeze systems can only set up in the more-quiet summer.

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DISTRIBUTION OF COPPER IN THE SEVERN RIVER SEDIMENTS AND OYSTERS

Researchers: Midshipmen 1/C James K. Foley and Gary K. Herrault

Adviser: Assistant Professor John W. Foerster

Copper concentrations were measured from Round Bay on the Severn to the mouth. A profile of the copper content of the bottom mud and oysters were similar. Oysters appeared to concentrate copper at levels three times greater than the bottom soils. Public Health aspects of these tests have not been addressed at this time.

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OCEANIC CURRENTS IN THE NEARSHORE AREA OF THE EASTERN COAST OF THE UNITED STATES

Researcher: Midshipman 1/C Gary Gordon

Adviser: Professor John F. Hoffman

This research project concerned reviewing various publications and assembling oceanic current data from South Carolina to New York. Ultimately, these data will be examined to see if any circulatory patterns exist between the western edge of the Gulf Stream and the shoreline of the mid-Atlantic states.

The literature-search included the use of the following sources: Oceanic Abstracts and the Defense Documentation Center computer. Other sources include individuals at Woods Hole Oceanographic Institute, the U. S. Geological Survey, The Johns Hopkins University, Environmental Protection Agency, NOAA, University of Rhode Island, University of Delaware, and the University of the State of New York.

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NAVY ACOUSTIC PREDICTION PROGRAMS - A TACTICAL/ENVIRONMENTAL VARIABILITY  
IMPACT STUDY

Researcher: Midshipman 1/C Steven D. Kinney

Adviser: Lieutenant Commander H. Lee Dantzler, USN

A survey of the Navy's acoustic prediction programs was made with emphasis on the products provided and the environmental inputs required.

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OBJECTIVE FORECASTING TECHNIQUES FOR ANNAPOLIS

Researcher: Midshipman 1/C Charles T. Lawson

Adviser: Lieutenant Commander Richard D. Anawalt, USN

This project evaluated climatological temperature data for Nashville, Tennessee, over a three year period (1974-1976) as a predictand for temperature forecasts in the Annapolis area by means of statistical-regression techniques. As expected, the seasonal effect dominated the correlations. However, after eliminating the season effect and providing for a 24-hour lag between the predictor and the predictand, sufficiently significant correlations remained to warrant investigating other stations which could be used in conjunction with Nashville to improve the correlations.

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DANTZLER, H. Lee, Jr., Lieutenant Commander, USN, "North Atlantic Fluctuation Energy Levels," in the Atlas of the Mid-Ocean Dynamics Experiment (MODE-1), Cambridge, Massachusetts: M.I.T. Press, 1977.

Expendable bathythermograph records combined with stability information show that a broad-zonal minimum in potential energy exists along 24-30°N in the eastern and western North Atlantic basins. From this minimum, potential energy levels increase significantly in magnitude to the north and to a lesser extent to the south with highest values indicated for the boundary-circulation-associated regions of the subtropical gyre. More geographically restricted maxima are found along the flanks of the Mid-Atlantic Ridge and near the Antilles Islands Arc, indicating that topographic influences may be important in addition to what appears predominantly to be a current-related potential energy field. Comparisons of these estimates with observations suggest that the areas of potential energy maxima are associated with significant eddy activity and that the conditions observed during MODE are statistically characteristic of the more quiescent central zone.

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DANTZLER, H. Lee, Jr., Lieutenant Commander, USN, "Potential Energy Maxima in the Tropical and Subtropical North Atlantic," Journal of Physical Oceanography, 7(1977), 512-519.

Expendable bathythermograph records are combined with stability information to provide estimates of the potential energy associated with vertical displacements in the tropical and subtropical North Atlantic thermocline. The geographic distribution of potential energy magnitudes provides a means by which the dynamics implications of thermocline displacements in areas of differing vertical-density structures can quantitatively be compared. A broad zonal minimum in potential energy exists along 24-30°N in the eastern and western North Atlantic basins. From this minimum, potential energy levels increase significantly in magnitude to the north and to a lesser extent to the south with highest values indicated for the boundary-circulation-associated regions of the subtropical gyre. More geographically-restricted maxima are found along the flanks of the Mid-Atlantic Ridge and near the Antilles Islands Arc, indicating that topographic influences may be important in addition to what appears predominantly to be a current-related potential energy field. Comparisons of these estimates with observations suggest that the areas of potential energy maxima are associated with significant eddy activity and that the conditions observed during MODE are statistically characteristic of the more quiescent central zone.

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FOERSTER, John W., Assistant Professor, "Management of the Northern Chesapeake Bay American Shad Fishery," Biological Conservation, 12 (1977), 179-201.

The shad fisheries of the Chesapeake Bay in Maryland have been declining since an 1897 peak of  $7860 \times 10^3$  kg. No periods of stability have been recorded. Data are presented to trace the decline not only as a function of specific areas within the Northern Chesapeake Bay but also in terms of environmental problems and recruitment overfishing. The problem is related to improving the commercial fishing yield. An estimation of a maximum effort of 200,000 man-hours is suggested if a stable yield is to be approached. Methods for obtaining this goal include alternating of closed fishing areas, adoption of rest days, enforcement of fisheries regulations, and reduction of a number of metres of gill net used by each fisherman.

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FOERSTER, John W., Assistant Professor, "And They Live by the Sea," Americas, 30 (1977), 36-42. (Published in English, Spanish, and Portuguese.)

This is a narrative of a study on fishermen and fisheries on a remote atoll 80 kilometers north of the Venezuelan Coast. A plan for management is presented with the socio-economic impacts.

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FOERSTER, John W., Assistant Professor, "Programming The Sargasso Sea," Contact, 3 (1977), 6.

This is a short account of the 1977 Summer Research Cruise and one of the participating scientists.

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FOERSTER, John W., Assistant Professor, "Sailing The Sargasso," All Hands, 731 (1977), 33-38.

This is a short narrative about using a sailing vessel for oceanographic research.

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HOFFMAN, John F., Professor, "An Investigation of New Methods for the Maintenance Dredging of Pier Slips." Proceedings of Coastal Zone '78, pp. 1083-1097.

Owing to the expense and awkwardness of utilizing the conventional methods of dredging (hopper dredge, pipeline dredge, bucket, and barge) for maintaining pier slips, it is desirable to develop a more convenient and, if possible, a more economical method of dredging pier slips.

Six methods of possible use in coping with the sedimentation problem at U. S. Navy pier slips were evaluated. These are: (1) Agitation dredging, (2) Pneuma system of dredging, (3) Dredging system utilizing educators, (4) Dixie dredge, (5) Mudcat dredging system, and (6) Marconoflo slurry system.

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HOFFMAN, John F., Professor, "Does Ship Channel Dredging Impair Ground Water Resources?" Proceedings of Coastal Zone '78, pp. 2167-2175.

Fresh water under an artesian head below the river-bay bottom at the confluence of the Patapsco River and Chesapeake Bay outside of Baltimore Harbor was observed during an offshore exploratory test-boring program. One of the principal purposes of the test-drilling program was to determine the characteristics of the spoil that would result from dredging a 300-foot-wide and more-than-one-mile long shipping channel to a depth of 50 feet below mean low water. This channel would provide access from Brewerton Channel, one of the main shipping channels in Chesapeake Bay, to a shore-side docking facility of a proposed 200,000 barrel per day oil refinery.

Problems encountered in recovering some of the sub-bottom Shelby-tube samples suggested an artesian condition below the waterway. Uncovering this aquifer during dredging opened the possibility that fresh water might be wasted to the Bay. Furthermore, any future heavy ground water withdrawal on shore might result in the intrusion of brackish Bay water into the aquifer. The presence of an artesian head may additionally produce slumping of the channel wall. Accordingly, a second exploratory program was undertaken to more closely appraise the situation.

This paper discusses the results of a program wherein a test point was driven offshore at selected locations through a casing to determine the variation of hydrostatic head and chloride concentration with depth.

Insufficient data are in hand to account for the artesian condition offshore. A possible explanation, however, is suggested by an analysis of test borings, drilled for the purpose of designing a power plant located on the site adjacent to the proposed refinery site. Evaluation of the

logs of these test borings suggest that intertwining streams may have existed at a time when sea level was lower than its present stand. Stream channels could have extended into the present waterway which at that time was exposed land. With the advent of rising sea level, the channels could have been filled with silt and sand carried down by streamflow and then subsequently covered over the silt and clay through estuarine action. These latter sediments would form the confining layers for an artesian condition. The filled stream channels would constitute the conduits for fresh water.

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SIMPSON, John P., Lieutenant Commander, USN, "Preliminary Description and Specifications for a Danish Coastal Marine Data Collection System," Office of Naval Research (London), R-7-77 Report, 25 July 1977.

To an increasing extent Denmark is faced with a series of problems linked with the safe navigation of large and deep draft ships through Danish waters. This is particularly important in the narrow and shallow fairways of the Baltic approaches, where the waters have a transient nature because of their position between the fresh Baltic and the saline Kattegat. Instantaneous sea level, sea state, current, sound speed, ice probability, and buoyancy are among the factors to be considered when navigating the Danish straits. The Royal Danish Administration of Navigation and Hydrography has undertaken the job of developing a system to measure or compute these parameters, providing "read-time" oceanographic data to transiting ships.

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PRESENTATIONS

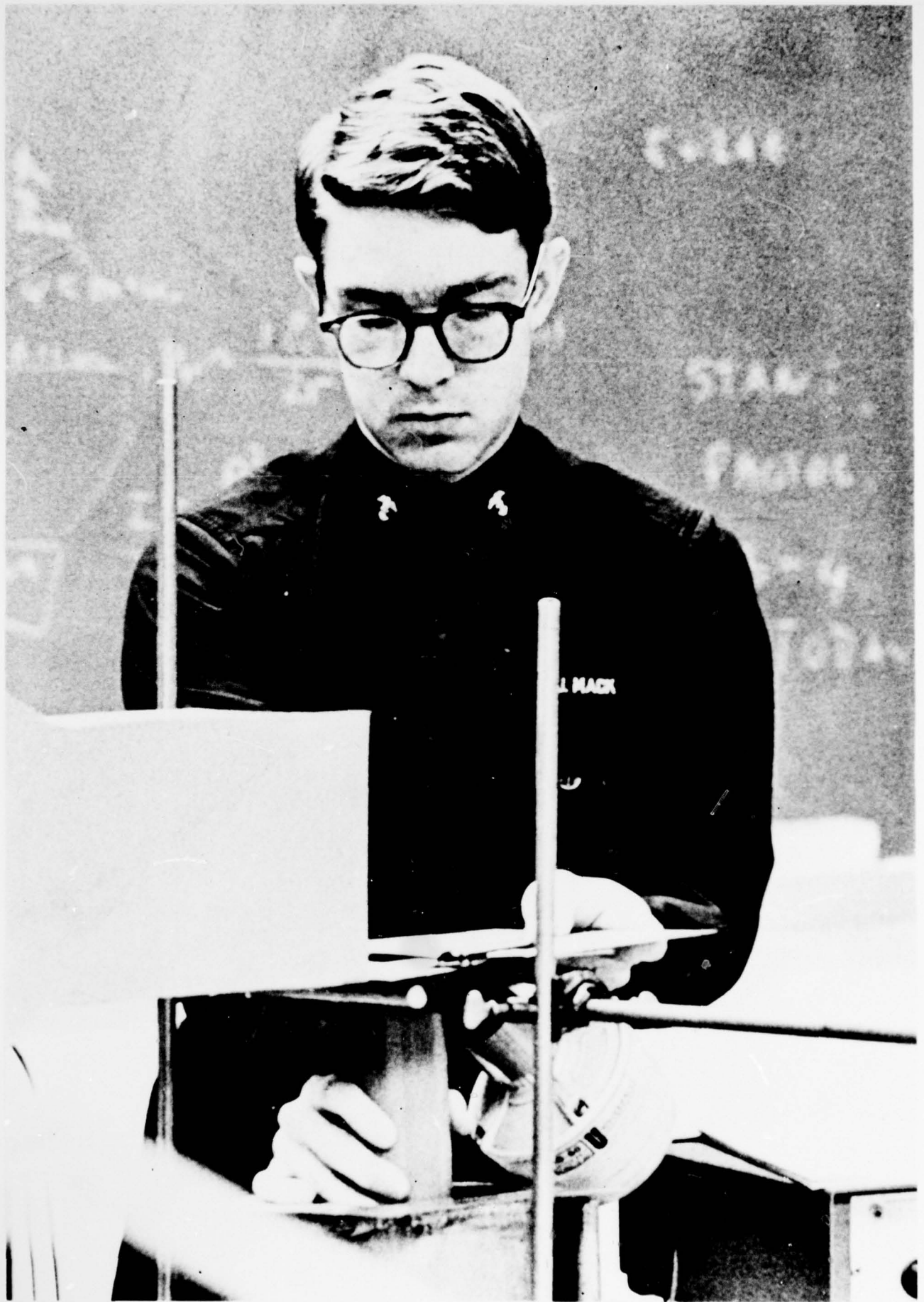
OCEANOGRAPHY DEPARTMENT

DANTZLER, H. Lee, Jr., Lieutenant Commander, USN. Presentation of Office of Naval Research-sponsored research at Naval Ocean Research and Development Activity, Bay St. Louis, Mississippi., 6-8 March 1978.

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FOERSTER, John W., Assistant Professor, "Oceanography Under Sail" (a 16mm-color, sound-film produced with the Naval Photographic Center). Presented at the Meeting of the Naval Academy Oceanography Club, April 1978.





## PHYSICS DEPARTMENT

*Professor Ralph A. Goodwin, Chairman*

The research program in the Physics Department continues to develop along several fronts. Present activity includes a cosmic ray group, a solid state group, and individual researchers in the electrical and magnetic properties of materials, acoustic cavitation, flow generated cavity resonance, stellar photometry, and theoretical problems. In each instance, midshipmen are, or have been, actively engaged in the research, either as Trident Scholars or through accredited research project courses.

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## THE THEORY OF RESONANT SCATTERING OF SOUND WAVES FROM LIQUID CAVITIES IN A VISCOELASTIC MEDIUM

Researcher: Associate Professor Donald Brill

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

Plane shear waves in a viscoelastic medium and incident to a spherical liquid inclusion are considered and a development of the scattered compressional and shear waves is undertaken. A resonant scattering technique familiar in nuclear scattering theory but novel to acoustics should display the results in a clear manner.

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## MECHANISM OF FLOW-EXCITED CAVITY RESONANCE

Researcher: Professor Samuel A. Elder

Sponsor: General Hydromechanics Research Program  
Naval Ship Systems Command, administered by  
David W. Taylor Naval Ship Research and Development Center

The technical objective has been to develop a physical model of the mechanism of Flow-Excited Cavity Resonance by means of which the effect can be controlled or eliminated in the design of ships and aircraft. Experimentally, the approach has been to map out the three-dimensional response of the separated shear layer above a resonant cavity for various flow conditions, using computerized hot-wire technique. From these data a conceptual model of the coupling mechanism between the oscillating shear layer and the acoustic field in the cavity has been developed. Recent results are being published in the Journal of the Acoustical Society of America. Simple accurate formulas have been derived for predicting the ratios of cavity-depth to slot-width that give rise to self-excited oscillation. Expected sound radiation amplitude has also been predicted to within a few dB for the cavities studied. It is found that there are certain conditions under which oscillation does not occur. Design criteria can be obtained from the theory. The off-resonance oscillation problem involves a complex root equation requiring numerical methods for solution. A program which produces solutions in all cases has been written for the HP97 programmable calculator. The present work has concentrated on air cavities. Further research is needed to study the applicability of the solutions obtained to underwater situations.

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GALACTIC STRUCTURE STUDIES

Researcher: Associate Professor William E. Fasnacht

Sponsor: Naval Academy Research Council

This investigation was an attempt to obtain density and epicyclic frequency as functions of radius by fitting the measured rotation curve of a galaxy with contributions from Bessel and Neumann function-potentials. The eventual goal was to obtain a differential equation for galactic density waves, which would presumably include spiral structure among the solutions.

After some preliminary theoretical analysis, the burden of the project was to obtain a least-squares fit of measured rotation curves using one of the computer programs developed, and from these solutions to compute the density and epicyclic frequency functions. Several dozens of such functions were calculated, primarily for our galaxy and for M 31.

Two major problems have brought the project to at least a temporary halt. First, there are a number of possible boundary conditions one can impose to help determine the weight terms for the series. The researcher has not established criteria that are both logical and good, in the sense that they lead to a particularly good fit of a rotation curve. Secondly, all schemes for determining weight functions have been far too sensitive to the details of the rotation curve far from the center of the galaxy, in precisely the region where the rotation curve is not well known--or in some cases, not known at all.

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PHYSICAL PROPERTIES OF MATERIAL AT ULTRA-HIGH PRESSURE

Researcher: Assistant Professor John J. Fontanella

Sponsor: Benet Weapons Laboratory, Watervliet Arsenal, U. S. Army

The objectives of the project are: (1) to design a capacitance configuration compatible with the Arsenal's 600 kilobar pressure cell which is capable of measuring the dielectric properties of the high pressure sample; (2) to develop suitable capacitance-measurement techniques in the 0.1 pico Farad range with suitable data output compatible with data storage capabilities at Watervliet; (3) to build "pill boxes" for use in specimen chamber of high pressure cell for simultaneous capacitance

ultrasonic and resistance measurements; and, (4) to measure dielectric properties of pyrophyllite and boron nitride with pressure. Preliminary design of the "pill boxes" and capacitance and conductance apparatus are complete. Construction is underway. Samples of pyrophyllite have already been evaporated and are ready for measurement.

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COMPUTER-AUGMENTED VIDEO EDUCATION FOR BASIC PHYSICS (CAVE)

Researcher: Associate Professor Billie J. Graham

Sponsor: Naval Academy (Academic Dean)

Both time-sharing computer facilities and video cassettes have a high potential for augmenting the teaching of physics, especially the introductory-level courses. This study was undertaken to determine how these two media could be merged and to determine if the resulting programs could effectively teach certain aspects of the basic physics laboratory.

Complementary time-sharing computer programs were written which asked questions or proposed problems associated with the material developed on a video-cassette tape. The video and computer material were interactive in that there was switching back and forth between the video tape and the time-sharing program at the points where it was strategically the best place to ask questions or pose problems.

Much time is required to teach students the techniques of organizing and using data taken in the laboratory. A CAVE (Computer-Augmented Video Education) program on lab techniques has been developed to provide students entering the basic physics course with either the background for handling laboratory data or a review when it is needed. This program, handled on an individual basis by the student, will leave more classroom time for discussing the more important fundamental concepts of physics. A similar program on projectile motion has also been developed.

\*\*\*\*\*

EFFECTS OF NEUTRONS ON THE LIGHT TRANSMISSION OF OPTICAL FIBERS

Researcher: Associate Professor Richard L. Johnston

Sponsor: Naval Research Laboratory

A research program to study the effects of fast neutrons on light transmission of optical fibers was begun.

The apparatus for making the measurements has been constructed and tested and a series of measurements will be made in the summer of 1978.

Because fiber optical transmission of information is being used to a greater extent in the Navy, it is important to know the effects of various kinds of radiations on the transmission properties.

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SOLAR IRRADIATION CONTRIBUTION TO RADIATIVE DETECTABILITY OF WARSHIPS

Researcher: Associate Professor Bruce H. Morgan

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The researcher carried out mathematical modeling of the infrared detectability of warships as a function of ambient conditions (insolation, effective sky temperature, air temperature, wind speed, and sea surface temperature) and ship's surface parameters (solar absorptivity and long wave emissivity), for flat horizontal surface with no heating or cooling from back side. He implemented the model on a computer and generated plots of infrared contrast in the 8 to 13  $\mu\text{m}$  band as function of wind speed for 16 representative environmental conditions. The results suggest that satisfactory low levels of radiative detectability cannot be achieved for all conditions by any choice of fixed values for solar absorptivity and thermal emissivity, and that active cooling or heating of the surface may be required.

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ACOUSTIC DAMPING OF BUBBLES

Researcher: Associate Professor David A. Nordling

Sponsor: Office of Naval Research and Naval Academy Research Council

The purpose of this project is to measure experimentally the acoustic damping of a bubble suspended in an acoustic field, with the principal goal being to compare the measured damping with existing theory.

The technique involves detecting light scattered from a bubble and comparing, in terms of phase, the modulation of the light intensity with that of the original signal.

The equipment was assembled and some measurements were made. The signal-to-noise was not such as to yield reliable data. Indications are that a need for a more sensitive detector exists.

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FERROMAGNETIC PERMEABILITY

Researcher: Associate Professor Carl S. Schneider

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

An experimental determination of the permeability of ferromagnetic materials as a function of applied field intensity, strain, and other parameters is underway. The details are classified.

The program is expected to continue for several years. This year's objectives were fully attained.

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DEFECT CHARACTERIZATION IN SEMICONDUCTORS USING DEEP LEVEL TRANSIENT SPECTROSCOPY

Researcher: Associate Professor Robert N. Shelby

Sponsor: Naval Research Laboratory

The objectives of this research are to develop systems for the characterization of defect or trap states in the junction region or near the interfaces of semiconductor devices, and to study radiation and fabrication produced defects in SiMOS and GaAs ion-implanted devices.

The technique called Deep Level Transient Spectroscopy (DLTS) will be used to characterize the defects in the semiconductors being studied. The work will be performed with Dr. N. Wilsey of the Radiation Effects Branch at the Naval Research Laboratory (NRL) during the summer and three days per month during the school year. The DLTS measurements and development will be done at NRL and sample preparation and initial sample characterization will be done at the Naval Academy with midshipmen participation where possible.

During the last two years of work, two DLTS systems have been assembled and tested, a 30 MHz system for low noise-high sensitivity work and a 1 MHz for more routine absolute measurements. Preliminary measurements have been made on irradiated Si junctions, SiMOS devices and GaAs ion-implanted devices. A paper on the defects in ion-implanted GaAs is in preparation for the 1978 International Conference on Defects and Radiation Effects in Semiconductors in Nice, France.

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## INITIAL CONDITIONS FOR ORBITAL RESONANCE IN A SATELLITE SYSTEM

Researcher: Midshipman 1/C Stephen M. Hopkins

Adviser: Professor Gerald P. Calame

Sponsor: Trident Scholar Program

The planetary motions of Neptune and Pluto exhibit a resonant behavior that keeps their orbits from intersecting, and that prevents the planets from approaching the nearest points of their orbits at the same time. Many astronomers, therefore, argue against the theory that Pluto could once have been a moon of Neptune that somehow escaped, even though much other evidence supports that theory. However, their argument appears fallacious in that once resonance is established in a system, all traces of the initial conditions are lost.

The present study begins with the assumption that Pluto was originally a moon of Neptune that escaped. A computer program which considers the perturbation on the orbit of Pluto due to the four major planets is then used to integrate the subsequent motion of Pluto forward in time, for a wide range of initial escape configurations. It is found that, over a range of initial conditions, the present resonant orbit is established in just a few hundred thousand years. The computer orbit shows the observed librations of Pluto around the aphelion conjunction, the proper eccentricity, and so on. Further, integration of the motion forward in time after the escape, and then subsequently integrating it backward in time, does not return Pluto to its initial position, showing that a resonance is truly established.

It is concluded that the argument against the escaped-moon hypothesis for the origin of Pluto based on a study of the present orbits is invalid.

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## RADIATION EFFECTS IN NEUTRON DOSIMETER MATERIALS

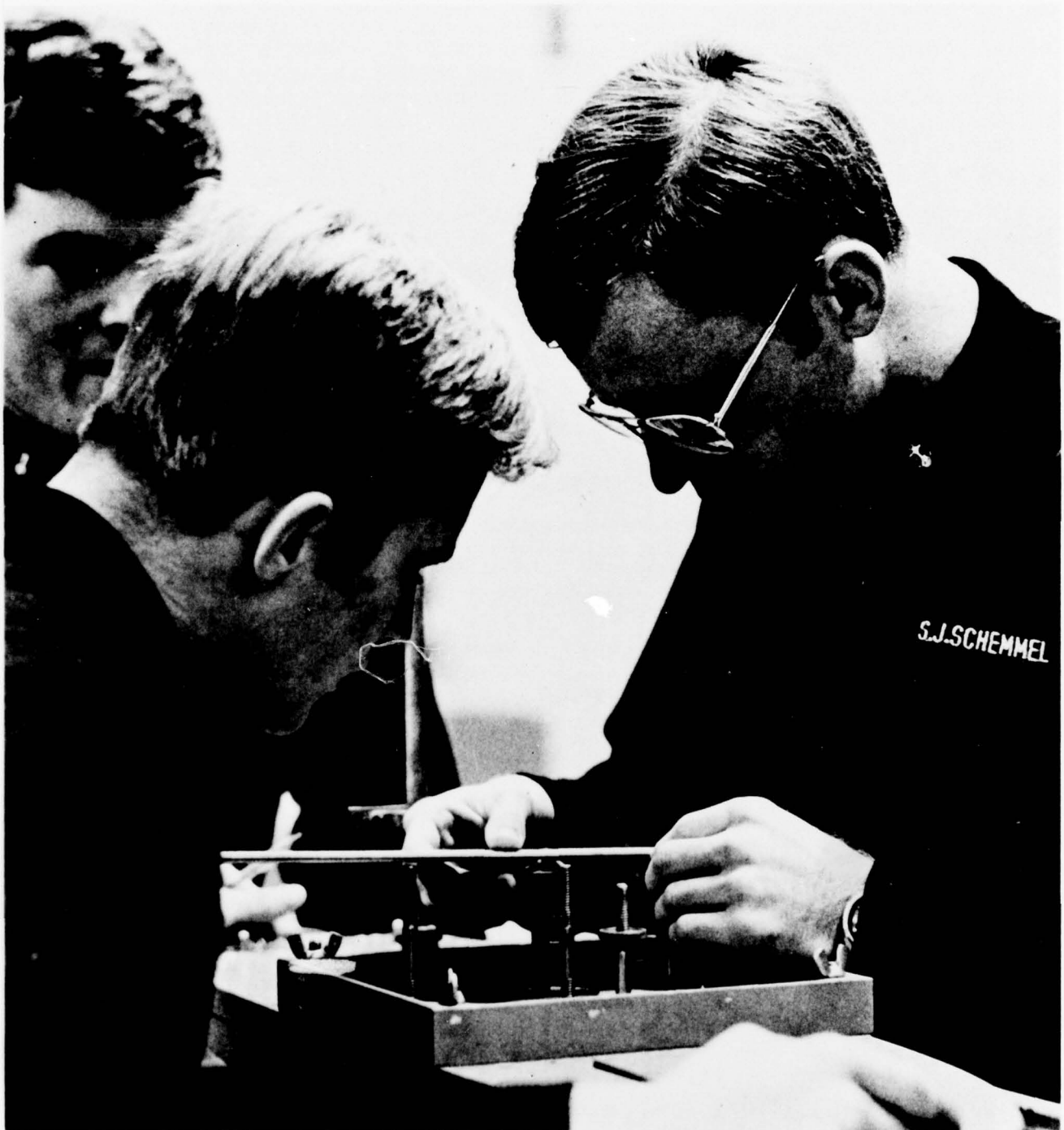
Researcher: Midshipman 1/C Greg Koldziejczak

Advisers: Assistant Professor John J. Fontanella and Associate Professor  
Richard L. Johnston

Sponsor: Trident Scholar Program

The effects of neutrons and gamma rays on rare-earth doped calcium fluoride have been studied using dielectric relaxation techniques. The available thermal and 14.7 MeV neutrons produced no observable changes in the dielectric spectrum of the materials. Gamma rays from a Co(60)

source, however, produced dramatic effects. The gamma rays both changed existing relaxations and induced new ones. The effects were studied as a function of dose rate, dopant concentration, and time (thermal anneal). The results contain useful information concerning the defect structure of rare-earth doped alkaline earth fluorides.



## EXPERIMENTS ON MAGNETIC MATERIALS

Researchers: Assistant Professor John P. Ertel and Associate Professor Carl S. Schneider

The construction and use of a simple apparatus to measure the magnetization density and magnetic susceptibility of ferromagnetic, paramagnetic, and diamagnetic solids and liquids are described. The universal presence of magnetism in a large variety of materials is graphically demonstrated, using the breakaway of the sample or bubble in the sample at the critical point where the magnetic force equals the extracting force provided either by pulley and string, tipped tube, or deflecting pendulum. The instrument has been calibrated both directly with gaussmeter probe and indirectly with NBS Standard samples of Al and  $MnCl_2$ . The sensitivity is  $0.2 \text{ nm}^3/\text{kg}$  in specific susceptibility ( $\chi_{\text{SPEC}} = \chi/\rho$  where  $\rho$  is density) while the precision is limited to about two percent due to sample size and field calibration. The apparatus is inexpensive to build, very sturdy, and simple to use and is valuable in demonstrations, student laboratories, and undergraduate research.

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## THE NUCLEAR QUADRUPOLE RESONANCE SPECTRUM OF DIBORANE

Researcher: Associate Professor Billie J. Graham

Diborane is the classic example of a unique group of electron-deficient compounds. Many techniques have been applied to study the physical characteristics of this compound to shed light on the unusual electron hydrogen bridging bonds. However, no studies on the nuclear quadrupole resonance spectrum have been reported, although such measurements can be extremely significant in that they give direct information on the ground state molecular-wave function.

The nuclear quadrupole-resonance spectrum of the  $^{10}\text{B}$  nucleus in diborane and that of the  $^2\text{D}$  nucleus in the deuterated compound ( $^{10}\text{B}_2\text{D}_6$ ) were obtained using the broad-line spectrometer at the National Bureau of Standards. Signal averaging was used to enhance the sensitivity of the measurements.

A computer program at the Naval Research Laboratory which generates simulated spectra from the nuclear magnetic-resonance-lineshape program was used to analyze the experimentally produced spectra. The coupling constants and the asymmetry parameters for the above nuclei were obtained when values input into the program produced computer simulated spectral lines which best fit the experimental spectral lines.

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DIELECTRIC STUDIES OF EPOXY FOR SUPERCONDUCTING MOTORS

Researcher: Midshipman 2/C David Beam

Adviser: Assistant Professor John J. Fontanella

The electrical conductivity and dielectric constant were measured at five audio frequencies over the temperature range 5.5-300 K for various samples of epoxy used as electrical insulation in superconducting motors. The frequency and temperature dependence of the conductivity indicate that some sort of "hopping" mechanism is responsible for the energy loss. Dielectric breakdown studies were carried out on the same samples over the same temperature range in an attempt to determine whether there is a correlation between the two sets of measurements. Data analysis is currently underway. The work was carried out in collaboration with the superconducting motor group at David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory.

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ELECTRICAL RELAXATION STUDIES IN RARE-EARTH DOPED STRONTIUM FLUORIDE

Researcher: Midshipman 2/C David Beam

Adviser: Assistant Professor John J. Fontanella

Samples of strontium fluoride doped with lanthanum, yttrium, and all the rare-earths except cerium, europium, gadolinium, and erbium have been ground, polished and prepared for dielectric measurements. Those measurements will complete dielectric studies of rare-earths in strontium fluoride. It is of interest to complete the set since ion-size effects have been found to be important in the kinetics of defect formation. Consequently, it will be useful to know which relaxations exist for which ions.

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STUDIES OF GEOMETRICAL EFFECTS ON SOLAR COLLECTOR EFFICIENCIES

Researcher: Midshipman 1/C Michael Fifer

Adviser: Assistant Professor John P. Ertel

The theoretical geometrical effects on solar collector efficiencies were studied as an SP495 project, resulting in a maximum optimization of some 25% on current upper limits.

The researcher is currently attempting to make mock-up measurements using various geometrical arrangements to check out the above results.

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## EFFECTS OF PRESSURE ON DIPOLE REORIENTATION IN RARE-EARTH DOPED ALKALINE EARTH FLUORIDES

Researcher: Midshipman 1/C Michael Hayden

Adviser: Assistant Professor John J. Fontanella

Additional data on the effects of pressure on dielectric relaxation in rare-earth doped calcium fluoride and strontium fluoride have been obtained. Analysis of the data is nearing completion. The new aspect of the data analysis includes incorporation of an extra parameter to account for peak broadening which becomes significant at higher dopant-concentrations. The new analysis should allow a believable value for the activation volume for various dipolar complexes.

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## DESIGN AND CONSTRUCTION OF AN AUTOMATED AUDIO-FREQUENCY CAPACITANCE AND CONDUCTANCE BRIDGE WITH DIGITAL OUTPUT

Researcher: Midshipman 1/C Thomas Lauzon

Adviser: Assistant Professor John J. Fontanella

The purpose of this project was to design and construct the interface between a General Radio GR-1615 Capacitance Bridge and an 8080-based microcomputer. The interface takes a three-bit code from the microcomputer and by the use of solid-state switches tunes the signal generator and detector to any one of five frequencies. The signal generator and detector are complete and operational. The output monitor and the software necessary to complete the design are currently under construction. The design is also being modified to use the MOS technology KIM-1 microcomputer.

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## OPTICAL ABSORPTION STUDIES IN ERBIUM DOPED CALCIUM FLUORIDE

Researcher: Midshipman 1/C R. D. McNaughton

Adviser: Associate Professor Donald J. Treacy

The work done in this project was an investigation of numerical methods for analyzing spectral data obtained on calcium fluoride crystals doped with various concentrations of erbium. The goal of the project was to obtain a quantitative analysis of the spectral region containing the  $E(4S_{3/2})$  manifold of the trivalent erbium ion. The quantitative results obtained from this study were the peak position and half-width of five

major absorptions of the erbium ion. Additionally, the optical density as a function of concentration of the  $\text{Er}^{3+}$  was obtained. These results are being correlated with dielectric relaxation spectra obtained on the same crystals. The most important result has been the correlation of three optical absorption bands with two dielectric relaxations. This type of correlation has never been done previously.

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## A PHOTOELECTRIC STUDY OF THE BINARY STAR W URSA MAJORIS

Researcher: Midshipman 1/C John Plencner

Adviser: Professor Graham D. Gutsche

A Johnson-type photoelectric photometer has been modified by adaptation of a different set of electronics (discriminator, linear amplifier and scaler) to provide a faster response to weak light sources. The photometer is being used in conjunction with the USNA 16-inch Cassegrain telescope to study the eclipsing binary star system W Ursa Majoris. The light curve of this star is being measured in two colors by direct comparison with a stable reference star. From the light curve, the period of the system and the nature of the eclipse can be determined. As this system has been studied in some detail before, the results will be a good measure to the new electronics and the techniques being employed. In addition to these observations, all of the previously written computer programs for data analysis are being rewritten in A.P.L. for greater ease and versatility. The results of this work will provide a sound basis for further research on eclipsing binaries at USNA.

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## DIELECTRIC RELAXATION STUDIES IN DOUBLE DOPED CALCIUM FLUORIDE

Researcher: Midshipman 2/C Michael Smith

Adviser: Assistant Professor John J. Fontanella

Samples of calcium fluoride doped with two different rare-earths have been ground, polished, and prepared for dielectric measurements. The results will be significant in the study of various cluster-associated relaxations. Specifically, in cases where distinguishable relaxations are observed from clusters made up of a single type of rare-earth, it is expected that "hybrid" responses should be observed for mixed clusters. Consequently, the results should provide useful information regarding the structure of clusters.

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ACOSTA, Virgilio, Associate Professor, and Billie J. GRAHAM, Associate Professor, co-authors, Curso de Fisica Moderna, Harla S. A. De C. V., Mexico D. F., 1975.

This book is a translation and adaptation of the author's book Essentials in Modern Physics. The translation was done in Mexico. The book is intended to be used in Latin America and Spain. Two more chapters have been added in Quantum Mechanics and two more in Solid-State Physics. Translation was done by Joaquin Sada Anaya who is the Chairman of the Physics Department of the National Polytechnic Institute of Mexico City. The Institute takes care of the education of the great majority of the engineers in Mexico. The book covers the usual areas of relativity, wave-particle duality, nuclear model of the atom, Bohr's theory, wave mechanics, nuclear physics, radioactivity, nuclear fission and fusion, solid-state physics, and ends with three chapters on astrophysics.

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ACOSTA, Virgilio, Associate Professor, and Billie J. GRAHAM, Associate Professor, co-authors, Essentials of Modern Physics, New York: Harper and Row, 1973.

This book has been translated into Polish (1978) by the International Department of Harper and Row. The new book contains some additional coverage of the section on solid-state physics.

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BRILL, Donald W., Associate Professor, co-author, "Sound Scattering from Thin Shells in the Kirchhoff Approximation," Journal of the Acoustical Society of America, 62 (December 1977), 1367.

The acoustic backscattering cross-section of a thin, air-filled elastic cylindrical shell is calculated using the Kirchhoff approximation. The spurious shadow-boundary reflections contained in the conventional formulation of the approximation are removed by the use of the stationary-phase method. Comparison with exact backscattering results based on the Watson-Sommerfeld transformation show a strong presence of creeping-wave contributions even for very thin shells.

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ELDER, Samuel A., Professor, "A Root Locus Solution of the Cavity Resonator Problem," David W. Taylor Naval Ship Research and Development Center Research Report E7801, February 1978.

Feedback amplifier analysis has been applied to the cavity resonator problem to account for the well-known frequency lock-in effect. A forward transfer function for large amplitude separated shear-layer oscillations

was derived as a result of careful experimental studies, using computerized hot-wire technique. Although the disturbance wavelength may be obtained from linearized theory, it was found that gain due to hydrodynamic instability is virtually absent for the large amplitudes encountered. A backward transfer function derived from organ-pipe theory was found satisfactory for the present configuration. Numerical root locus solution was implemented on an HP97 programmable calculator. Good agreement between theory and experiment is obtained both for frequency and amplitude.

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FONTANELLA, John J., Assistant Professor, and Donald LINK, Midshipman 1/C, co-authors, "Cluster-Associated Relaxations in Rare-Earth Doped Calcium Fluoride," Physical Review, B 16 (1977), 3762-3767.

The complex dielectric constant has been measured at five audio frequencies over the temperature range 5.5-400 K for calcium fluoride doped with thirteen different rare-earths. Five relaxations are observed which are characteristic of rare-earths in calcium fluoride. Two of the relaxations do not exist for large rare-earth ions. Both are attributed to clusters. Next, a relaxation is found with an activation energy which varies from 0.4 to 0.9 eV approximately linearly with the radius of the rare-earth ion. Since this relaxation is found to exist only for higher concentration samples, it, too, is attributed to clusters in contradiction to a previous identification. Finally, a new relaxation characteristic of rare-earths in calcium fluoride has been observed.

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FONTANELLA, John J., Assistant Professor, co-author, "Dielectric Relaxation in Yttrium and Lanthanum Doped Calcium Fluoride," Physical Review, B 17 (1978), 3429-3431.

The complex dielectric constant has been measured at five audio frequencies over the temperature range 5.5-400 K for 0.1 mol-% of yttrium and lanthanum in calcium fluoride. Five relaxations are observed in the yttrium doped material, and one is observed for lanthanum. These results are consistent with trends with ion-size observed previously for rare-earths in calcium fluoride and emphasize that ion-size is the primary factor determining defect formation in calcium fluoride doped with trivalent ions.

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FONTANELLA, John J., Assistant Professor, Donald J. TREACY, Associate Professor and Richard L. JOHNSTON, Associate Professor, "Dielectric Relaxation in Rare-Earth and Alkali Metal Doped Alkaline Earth Fluorides," International Conference on Defects in Insulating Materials, (1977), 13-14.

The complex dielectric constant has been measured at five audio frequencies over the temperature range 5.5-400K for a variety of rare-earth and alkali metal doped alkaline earth fluorides.

Fourteen rare-earths and yttrium have been studied in calcium fluoride at a nominal concentration of 0.1 mol-%. Thirteen of the rare-earths have also been studied at 1.0 mol-%. Five independent relaxations are observed, and it is concluded that at least three are cluster-associated. The activation energy for one of the three cluster-associated relaxations is found to depend strongly on the nature of the rare-earth ion and varies approximately linearly with the radius of the rare-earth ion between values of about 0.4 and 0.9 eV. The other two cluster-associated relaxations do not exist for rare-earths larger than europium in the as-received samples. Various cluster models such as dimer ions and trimers are proposed in an attempt to explain the results.

Four rare-earths in strontium fluoride in two concentrations 0.1 and 1.0 mol-% were also studied. Erbium was also studied at a nominal concentration of 0.1 mol-%. The usual Type I and Type II dipoles are found to continue increasing in strength up to the highest concentration studied. The relaxations are not very Debye-like. Consequently, the actual activation energies, as determined in the present experiment, are significantly higher (on the order of 0.1 eV) than those reported by other methods. A third relaxation is found only in the highest concentration samples and has a low activation energy similar to that for one of the cluster-associated relaxations observed in calcium fluoride. An analogous relaxation is not found in erbium doped barium fluoride to concentrations of 1.0 mol-%.

Finally, results for 0.1 mol-% of lithium, sodium, and potassium in calcium fluoride were obtained. The interesting feature of that work is that the activation energy for the principal relaxation in these materials does not vary monotonically with the size of the alkali metal ion. In order of increasing activation energy, the dopants are potassium, lithium, and sodium. Further work on these materials is necessary, however, since the potassium doped sample was obtained from a source different from the other two. (This research was supported by the U. S. Army Research Office.)

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FONTANELLA, John J., Assistant Professor, and Donald J. TREACY, Associate Professor, co-authors, "Optical and Dielectric Absorption Studies in Erbium Doped Calcium Fluoride," Bulletin of the American Physical Society, 23 (1978), 548.

Optical absorption measurements have been carried out at liquid helium temperature on various samples of erbium doped calcium fluoride using a Cary-17 recording spectrophotometer. The measurements have been performed on various samples over the concentration range 0.001-3.0 mol-% both before and after a vacuum anneal at 1120 K followed by a quench to room temperature. Audio frequency dielectric relaxation studies have also been carried out on the materials. A strong correlation is found between various peaks in the optical and dielectric absorption spectra. The results provide new information concerning the origin of dielectric relaxation and hence defect configurations in rare-earth doped calcium fluoride. (This research was supported by the U. S. Army Research Office.)

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FONTANELLA, John J., Assistant Professor, and Richard L. JOHNSTON, Associate Professor, co-authors, "Temperature and Pressure Variation of the Refractive Index of Diamond," Applied Optics, 16 (1977), 2949-2951.

The temperature and pressure variation of the refractive index for a Type-IIa diamond have been measured at audio frequencies using capacitance techniques. Measurements have been made at zero pressure over the temperature range 5.5-340 K and at pressures up to  $1.4 \times 10^8$  Pa. (1.4kbar) at room temperature. At room temperature,  $(1/n)(dn/dT)_p = + 4.04 \times 10^{-6}/^\circ\text{K}$  and  $(1/n)(dn/dp)_T = - .36 \times 10^{-12}/\text{Pa}$ . In addition, the curvature in the refractive index with temperature has been determined. The first order derivatives are compared with previous experimental data and the recent theoretical calculations of VanVechten, and Yu and Cardona.

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FONTANELLA, John J., Assistant Professor, and Greg KOLODZIEJCZAK, Midshipman 1/C, co-authors, "Radiation Effects in Rare-Earth Doped Calcium Fluoride," Bulletin of the American Physical Society, 23 (1978), 254.

Several kinds of rare-earth doped calcium fluoride have been irradiated with  $\gamma$ -rays from a  $\text{Co}^{60}$  source. The complex dielectric constant has been measured over the temperature range 5.5-390 K at several audio frequencies for each sample both before and after irradiation. The  $\gamma$ -rays had a measurable effect on the dielectric spectrum of each material; however, samarium doped calcium fluoride proved to be the most sensitive. Specifically, strong relaxations were

induced in the regions where stable  $R_{II}$  and  $R_{III}$  relaxations exist for small rare earths in calcium fluoride. In addition,  $R_{IV}$  was significantly diminished by the  $\gamma$ -rays. All of the effects were unstable, however, and measurements were made of the change in the radiation induced effects with time. The results are used to discuss possible origins of the various relaxations. (This research was supported by the U. S. Army Research Office.)

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HOPKINS, Stephen M., Midshipman 1/C, "Initial Conditions for an Orbital Resonance in a Satellite System," Trident Scholar Project Report Number 91, U. S. Naval Academy, Annapolis, 1978.

A computer program was developed to investigate the formation of resonances among planetary orbits. It was used to examine the conditions of 3/2 resonance between the planets of Pluto and Neptune and try to determine whether it was possible for Pluto to have escaped from Neptune. It was established that Neptune and Pluto are in resonance, consequently they would never come close enough to one another for Pluto to have been a moon of Neptune.

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KOŁODZIEJCZAK, Gregory C., Midshipman 1/C, "Radiation Induced Dielectric Relaxation in Rare-earth Doped Calcium Fluoride," Trident Scholar Project Report Number 93, U. S. Naval Academy, Annapolis, 1978.

Low frequency dielectric properties of rare-earth doped calcium fluoride crystals were studied over a temperature range of 5.5°K to 380°K. Low flux neutron radiation was found to have no effect. Gamma rays, on the other hand, were found to significantly effect these properties. Experiments are discussed in detail. The results support the hypothesis that  $R_1$  is from isolated dipoles,  $R_2$  is from simple clusters, and  $R_3$ ,  $R_4$  and  $R_5$  are from more complex clusters.

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SCHNEIDER, Carl S., Associate Professor, and John P. ERTEL, Assistant Professor, "Experiments on Magnetic Materials," American Journal of Physics, 46 (1978), 800.

The scarcity of undergraduate experiments on magnetic materials prompted the development of a "Magnetism Box" which allows measurements of the magnetization density and demagnetization factor of ferromagnetic samples, and the susceptibility of both paramagnetic and diamagnetic solids and liquids. The instrument use and theoretical analysis are simple and the experimenter can achieve nearly one per-cent precision with a sensitivity of 0.2<sup>3</sup>nm/kg in specific susceptibility. Use in demonstrations, student laboratories, and undergraduate research is suggested.

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TREACY, Donald J., Associate Professor, and John J. FONTANELLA, Assistant Professor, "Annealing Studies in Erbium Doped Alkaline Earth Fluorides," International Conference on Defects in Insulating Crystals, (1977), 440-441.

Samples of  $\text{CaF}_2:\text{Er}$ ,  $\text{SrF}_2:\text{Er}$ , and  $\text{BaF}_2:\text{Er}$  having nominal concentrations of 0.01, 0.1, and 1.0 mol-% were annealed in vacuum at 1120 K and quenched by withdrawing the annealing tube from the furnace. (An additional sample of 0.3 mol-%  $\text{CaF}_2:\text{Er}$  was also studied.) The vacuum was of the order of  $10^{-6}$  Torr. The samples remained clear after this treatment. The crystals were examined before and after treatment using optical and dielectric spectroscopy. The optical spectra were taken on a Cary-17 recording spectrophotometer and the dielectric data were obtained using apparatus described elsewhere.

Five relaxations were studied in  $\text{CaF}_2:\text{Er}$ . The lowest temperature, 0.03 eV, relaxation, which grows monotonically with concentration and is thought to be cluster-associated, was observed to decrease when the samples were annealed and quenched. In the 0.3 mol-% sample, for example, the 0.03 eV relaxation decreased by a factor of three. The 0.15 eV relaxation, on the other hand, grew by a factor of ten and the 0.4 and 0.55 eV relaxations each grew by a factor of three. The optical absorption bands recently associated with clustered rare-earth ions showed a decrease. An increase in absorption bands associated with relaxations having tetragonal symmetry was observed. The magnitude of the increase in the tetragonal absorption bands was close to three.

In the  $\text{SrF}_2:\text{Er}$  where the low temperature dielectric relaxation is not observed until higher concentrations than in the  $\text{CaF}_2:\text{Er}$  the samples show little change upon annealing and quenching at concentrations less than 1.0 mol-%. The 1.0 mol-% samples show a decrease in the low temperature relaxation upon annealing and quenching. Some growth has been observed at intermediate temperatures. No substantial change in the principal relaxation was observed. The D.C. conductivity was significantly enhanced at high temperatures. The optical absorption spectra showed a substantial decrease in spectral regions similar to the  $\text{CaF}_2:\text{Er}$ . No growth in absorption was observed.

In the  $\text{BaF}_2:\text{Er}$  samples, where no low temperature, cluster-associated relaxation is observed up to concentrations of 1.0 mol-%, the dielectric spectrum showed no significant changes other than an increased D.C. conductivity. The optical spectra, on the other hand, showed a decrease in absorption similar to that observed for  $\text{CaF}_2:\text{Er}$  and  $\text{SrF}_2:\text{Er}$ . No increase in absorption was observed.

Further experiments were conducted to attempt to restore the samples to their original state. Samples of  $\text{CaF}_2:\text{Er}$  having concentrations of 0.3 mol-% and 1.0 mol-% were annealed in vacuum at temperatures of 620 K, 645 K, 670 K, and 695 K for 15 minutes and quenched in the same manner as the original quenching. In the 0.3 mol-% sample, the changes in the optical spectrum were found to be reversible. The dielectric spectra, however, showed no changes in the three peaks which grew after the original annealing and quenching.

The general conclusion of this set of experiments is that the optical and dielectric spectra are only weakly correlated. (This research was supported by the Naval Academy Research Council.)

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TREACY, Donald J., Associate Professor, co-author, "Two-phonon Vibrational Spectra of  $\text{As}_2\text{S}_3$ . I. Crystalline Phase," Physical Review, B 16 (1977), 4501.

Polarized two-phonon Raman and infrared spectra of crystalline  $\text{As}_2\text{S}_3$  have been measured at 300 and 80 K. Evidence of vibrational decoupling of the normal modes of the crystalline layer into inter- and intra-chain vibrations is presented. The observed narrowness of many of the two-phonon spectral features of the crystalline form is attributed to the layered nature of the crystal structure and to the vibrational decoupling of the layer modes.

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TREACY, Donald J., Associate Professor, co-author, "Two-phonon Vibrational Spectra of  $\text{As}_2\text{S}_3$ . II. Comparison of the Crystalline and Amorphous Forms," Physical Review, B 16 (1977), 4511.

Polarized two-phonon Raman and two-phonon infrared spectra of amorphous  $\text{As}_2\text{S}_3$  have been measured at 300 and 80 K and compared to analogous spectra of crystalline  $\text{As}_2\text{S}_3$ . The comparison of the two-phonon spectra of the crystalline and amorphous forms leads to a better understanding of those vibrational modes which determine the subtleties of the Raman and infrared spectra in the glassy phase. In particular, this comparison suggests that, when the effects of local fields are included, some selection rules imposed by the crystalline layers may also be applicable to the glassy phase. However, great caution must be exercised in any attempt to draw structural inferences from these vibrational data.

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ELDER, Samuel A., Professor, "Prediction of Interface Wave Profile for a Flow-Excited Cavity Resonator," Session H, 95th Meeting of Acoustical Society of America, Providence, Rhode Island, 16 May 1978.

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ELDER, Samuel A., Professor, "The Problem of Unwanted Organ Pipes," Colloquium at Planning Systems, Inc., McLean, Virginia, 2 June 1978.

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FONTANELLA, John J., Assistant Professor, and Lawrence M. Hayden, Midshipman 1/C, "Activation Volumes for Dipolar Complexes in Rare-Earth Doped Alkaline Earth Fluorides," Sixth AIRAPT (International Association for the Advancement of High Pressure Science and Technology) International High Pressure Conference, Boulder, Colorado, 25-29 July 1977.

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FONTANELLA, John J., Assistant Professor, and Donald J. TREACY, Associate Professor, "Annealing Studies in Erbium Doped Alkaline Earth Fluorides," International Conference on Defects in Insulating Crystals, Gatlinburg, Tennessee, 9-14 October 1977.

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FONTANELLA, John J., Assistant Professor, Richard L. JOHNSTON, Associate Professor, and Donald J. TREACY, Associate Professor, "Dielectric Relaxation in Rare-Earth and Alkali Metal Doped Alkaline Earth Fluorides," International Conference on Defects in Insulating Crystals, Gatlinburg, Tennessee, 9-14 October 1977.

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FONTANELLA, John J., Assistant Professor, and Donald J. TREACY, Associate Professor, "Optical and Dielectric Absorption Studies in Erbium Doped Calcium Fluoride," Spring Meeting of the American Physical Society, Washington, D. C., 24-27 April 1978.

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FONTANELLA, John J., Assistant Professor, Richard L. JOHNSTON, Associate Professor, Greg KOLODZIEJCZAK, Midshipman 1/C, and David BEAM, Midshipman 2/C, "Radiation Effects in Rare-Earth Doped Calcium Fluoride," Student Section of the American Nuclear Society, Lowell, Massachusetts, 30 March-1 April 1978.

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FONTANELLA, John J., Assistant Professor, and Greg KOLODZIEJCZAK, Midshipman 1/C, "Radiation Effects in Rare-Earth Doped Calcium Fluoride," March Meeting of the American Physical Society, Washington, D. C., 27-30 March 1978.





DIVISION OF  
PROFESSIONAL DEVELOPMENT



## LEADERSHIP AND LAW DEPARTMENT

*Commander John Luke, USN, Chairman*

Research in the Leadership and Law Department is primarily problematic and designed to produce outcomes directly useful at an operational level. Members of the staff not only direct programs of research as project managers, but they do a considerable amount of research-consulting and evaluation for the Division of Professional Development. Assistant Professor Harrison of this Department acts as the Division Research Coordinator and is in charge of most of the research. He in turn utilizes support staff from the Department and Division in carrying out specific projects.

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## ASSIGNMENT PROGRAM

Researchers: Assistant Professor Patrick R. Harrison and Gene Hillman  
(Admissions Office)

Sponsor: Naval Academy (Division of Professional Development)

This program of research deals with three separate problems: retention of high-risk midshipmen, women roommate inflexibility, and general room assignment. The goals are to improve retention and performance. A tentative regression model predicting high risk women is currently being validated. Alternate room assignment procedures are being tested this summer. This research program also involves the Naval Personnel Research and Development Center, San Diego.

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## QUANTITATIVE SEQUENTIAL MODELS OF CAREER AND ADULT DEVELOPMENT FOR SURFACE WARFARE OFFICERS

Researcher: Assistant Professor Patrick R. Harrison

Sponsor: Naval Academy (Division of Professional Development)

This research has two main objectives: (1) to develop an adequate quantitative sequential model for the analysis of developmental data, and (2) to use this model to describe Surface Warfare Officer Career development with respect to professional development, qualifications, and time. Career development in this case refers to the classes of billets, formal learning environments, and the levels of responsibility and authority that the officer normally tracks through during the course of his/her active duty career.

The focus of the conceptual model at this point is on the sequence, timing, and kinds of ecologies the person tracks through. This system is paralleled by a maturational-structural orchestration that is continuous and interactive with the ecological system.

This quantitative model is a hybrid of the basic econometric model proposed by Karl Joreskog, modified to include state variables and fuzzy restrictions.

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SAMPLING SEQUENTIALLY-ORDERED CATEGORICAL DATA IN OBSERVATIONAL STUDIES OF SOCIAL INTERACTION

Researcher: Assistant Professor Patrick R. Harrison

Sponsor: Naval Academy Research Council

Typically the data constructed in observational research consists of a set or mutually exclusive sets of unordered categorical variables. In order to obtain a sequential analysis of such data, the descriptors must be ordered with respect to time. Three ways that behavior may be mapped into descriptors that preserve order with respect to time consist of recording descriptors (1) continuously in time with an instrument like a multipen or key recorder, (2) as occurrences within discrete time-sampling intervals, or (3) as incidents during a behavioral unit. If data have been recorded continuously in time, then one must form discrete time-intervals so that a descriptor occurs no more than once within an interval, even though more than one descriptor may occur. The same rule holds for forming discrete time-intervals before observing occurrences. With behavioral unit coding, the unit acts like a time-interval and the unit must be defined so that a descriptor occurs no more than once. The first two possibilities have been called counts-of-incidents of behavior with reference to equate time-intervals, and the third possibility occurrences of behavior independent of duration. All three are forms of modified frequency counting procedures.

The research is aimed at investigating theoretically and empirically the relationship between modified frequency data and raw frequency and duration. It is the author's contention that the two systems bear a predictable relationship and that the failure to distinguish behavioral incident from behavioral state has been at the root of the lack of predictability in past studies.

Continuous pen-recordings of behavior will be reanalyzed with respect to various counting techniques including modified frequency, event- and state-sampling, and raw frequency and duration. These will then be subjected to comparative analysis using correlational and regression techniques. Secondly, the actual data will be used to generate the observed distributions and develop the parameters of the expected distributions for each sampling technique. This process is aimed at developing a statistical test of the probable goodness of fit between the derived approximation of raw frequency and duration and the expected in terms of parameters such as interval overlap, interval size, and length of modified data strings.

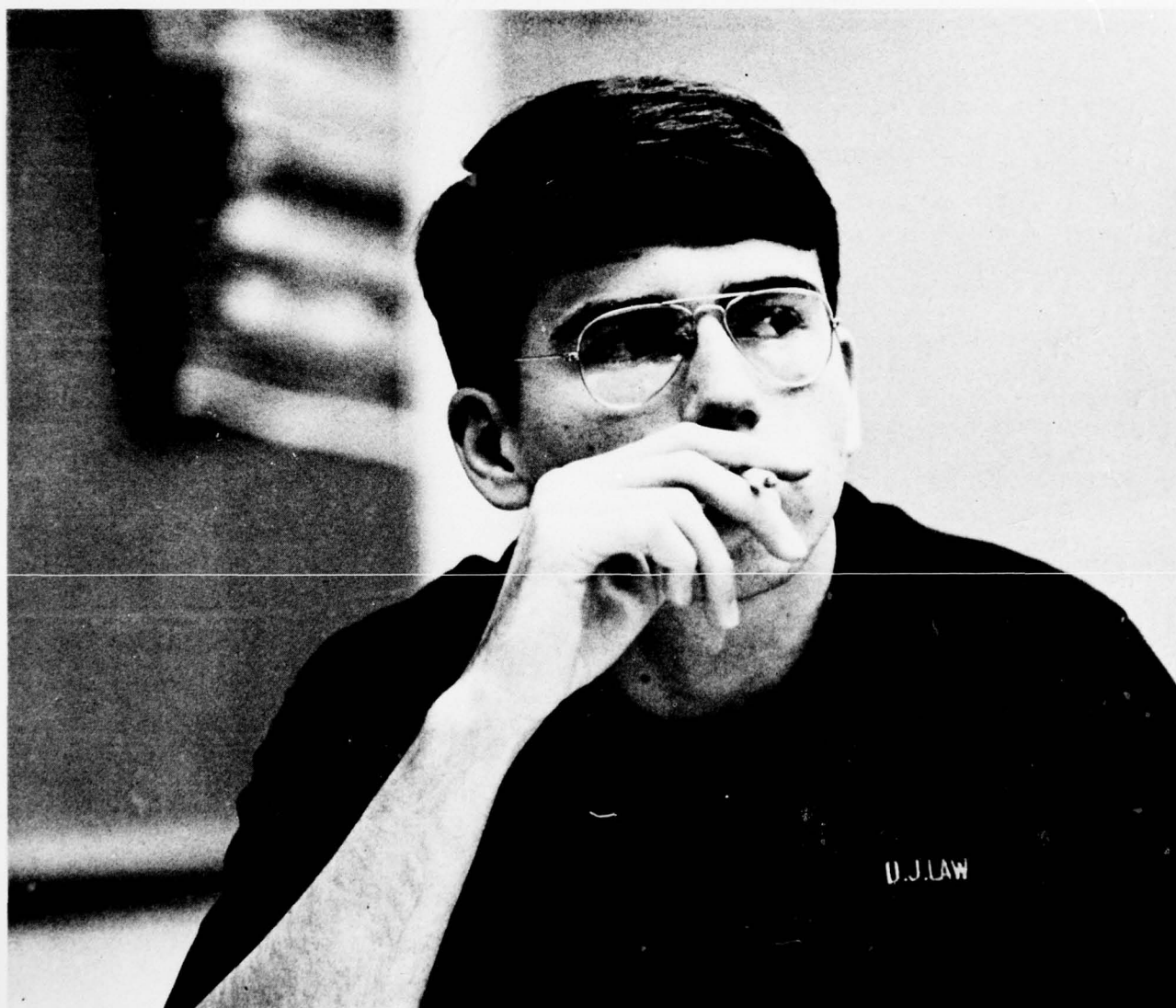
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WOMEN AT THE NAVAL ACADEMY

Researcher: Assistant Professor Patrick R. Harrison

Sponsor: Naval Academy (Division of Professional Development)

This is a program of research involving a number of different individual research problems. The purpose of this program is to monitor the integration of women at the Academy and to provide data useful at the operating and policy levels. This program also involves the Naval Personnel Research and Development Center, San Diego, and Dr. Edith Seashore, consultant to the Division of Professional Development on the integration of women.



ONTOGENY OF VISUAL HABITUATION

Researcher: Assistant Professor Patrick R. Harrison

A series of six studies that sequentially analyze visual habituation over the first seven years has been completed. A two-process model of habituation emerges. Papers are currently being readied for publication.



HARRISON, Patrick R., Assistant Professor, co-author, "The Sequential Analysis of Visual Habituation in Preschool Children," Journal of Experimental Child Psychology, 24 (1977), 495-504.

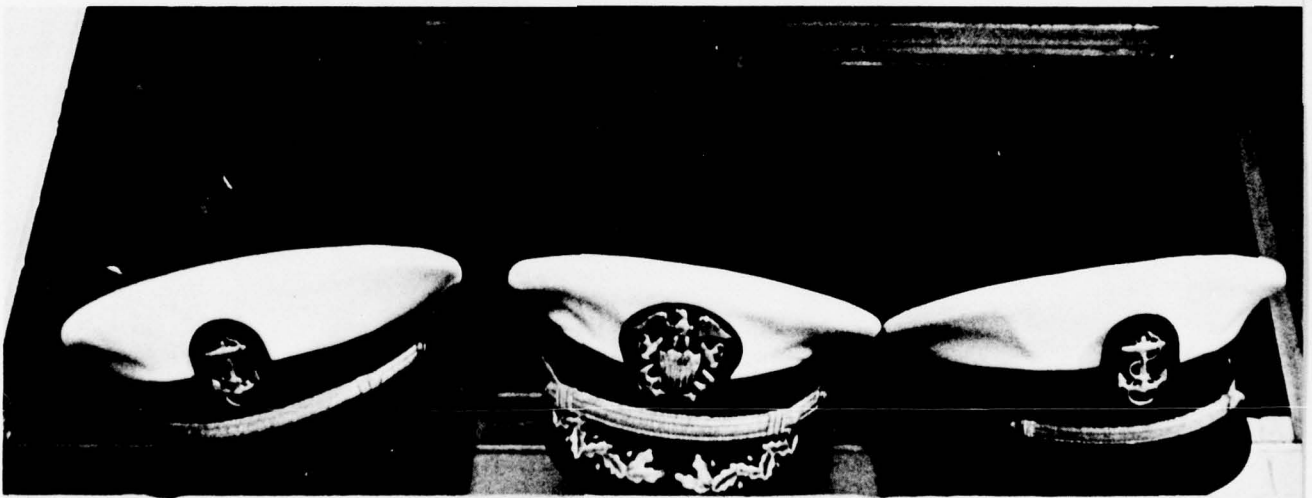
This study breaks down the data from a preschool (mean age of students, 63 months) visual habituation experiment using a second-by-second analysis of the entire process, including fixation time and onsets for habituation and recovery trials and for each intertrial interval. The results parallel those suggested by Cohen, DeLoach, and Rissman (Child Development, 1975) for infants and are described using a two-process model of visual attention.

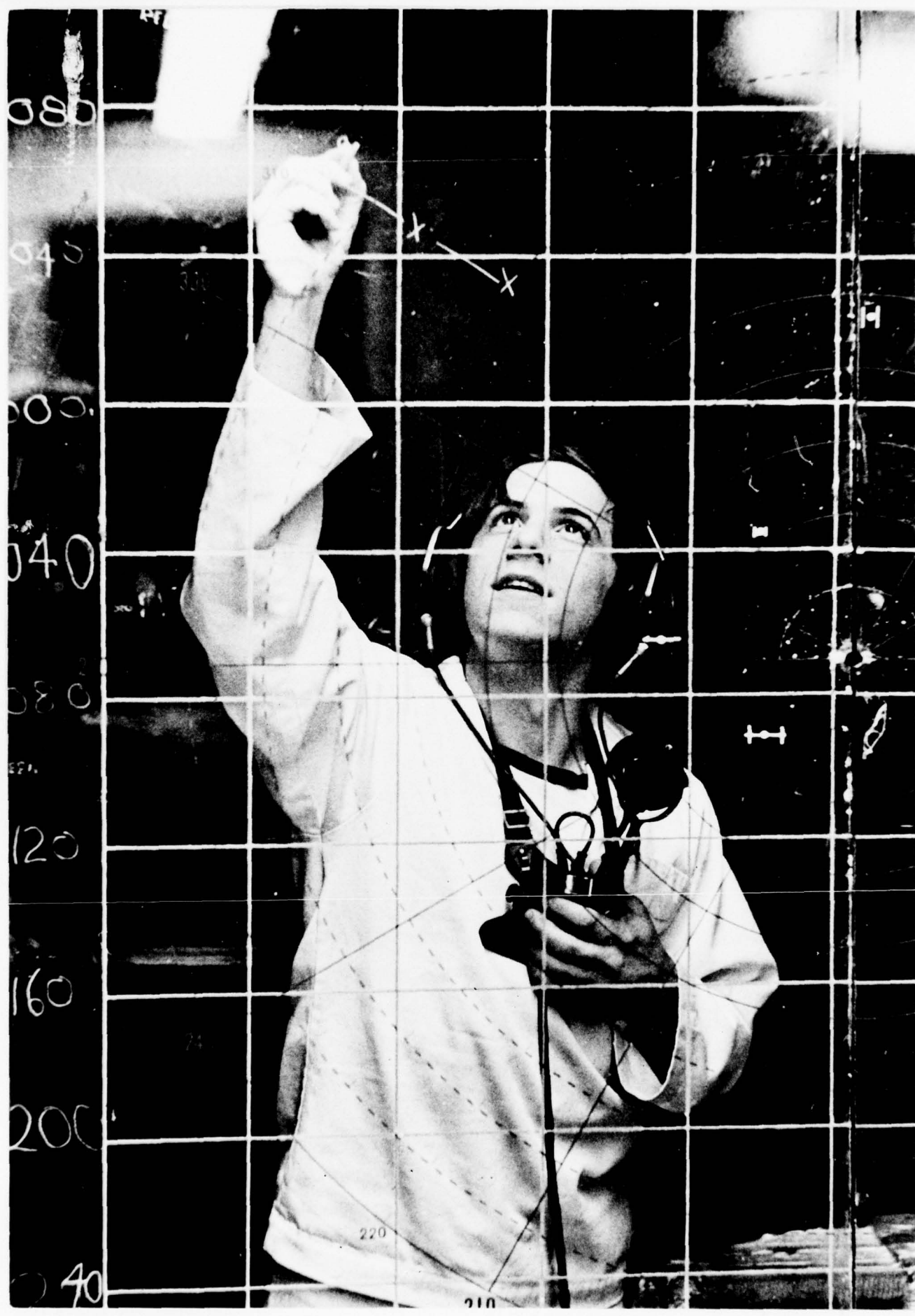


PRESENTATIONS

LEADERSHIP AND LAW DEPARTMENT

GARVIN, Patricia, Lieutenant, USNR, and Patrick R. HARRISON, Assistant Professor, "Identification With the Aggressor: A Factor in Attrition," Annual Academies Counselling Conference, U. S. Coast Guard Academy, Spring 1978.





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## SEAMANSHIP AND NAVIGATION DEPARTMENT

*Commander Peter D. Abbott, USN, Chairman*

War-gaming (manual and computer-assisted) was further incorporated into two courses taught by this Department. In the Third Class course, Shiphandling and Tactics, NS252, the manual game has been used to arouse student interest in tactics and platform capabilities. The First Class course, Naval Tactical Warfare Seminar, NS400, has advanced from a trial basis in the Spring Semester, 1977, to course-wide usage.

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**WAR-GAMING IN THE PROFESSIONAL CURRICULUM**

Researchers: Lieutenant R. Steven Herbert, USN; Ronald E. LaDue, and  
Ronald R. Lambert (Academic Computing Center)

War-gaming in the Naval Tactical Warfare Seminar, NS400, began during the fall semester of 1977. Since that time, continuing efforts have been made to adapt the Naval Tactical Game (NAVTAG) for computerized use.

During the 1977-78 Academic Year, extensive progress was made in the formulation and refinement of five tactical scenarios which utilize a tactically significant ship inventory of U.S. and U.S.S.R. assets. The scenarios and variations that have been developed include:

- |  |    |   |
|--|----|---|
| A. SPRUANCE (DD) (1)<br>or KNOX (FF) (1)   | vs | SHERSHEN (PT) (6)   |
| B. ADAMS (DDG) (1)<br>or COONTZ (DDG) (1)  | vs | KYNDA (CG) (1)  |
| C. CALIFORNIA (CGN) (1)<br>or BELKNAP (CG) (1)<br>GEARING (DD) (1)                               | vs | KRESTA II (CG) (1)<br>or KRESTA I (CG) (1)<br>SAM KOTLIN (DDG) (1)<br>PETYA (FF) (1)<br>ALLIGATOR (LST) (1) |
| D. A-7E (15)<br>EA-6B (3)  | vs | KIEV (CV) (1)<br>or KARA (CG) (1)   |
| E. AMERICA (CV) (11)<br>ADAMS (DDG) (1)<br>KNOX (FF) (1)<br>GEARING (DD) (1)<br>BELKNAP (CG) (1) | vs | 'N' CLASS SUBMARINE (1)   |

Four of the five computerized scenarios were used extensively throughout the spring semester of NS400 and were found to generate increased student participation, enthusiasm, and tactical awareness. As a result all five scenarios will be used as the primary portion of NS300T, a new one-week summer course for all Second Class midshipmen, designed to provide a participatory introduction to naval warfare.

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MANEUVERING BOARD PROBLEMS ON THE COMPUTER

Researcher: Lieutenant John Scott, USN, and Lon Ward (Academic Computing Center)

Maneuvering board problem solution is a source of much confusion for midshipmen. In an effort to provide an additional source of instruction, a program which generates maneuvering board problems was originated. The program, referred to as MANEUVER, randomly produces a fixed set of "believable" at-sea problems for the student to solve.

MANEUVER materializes two "ships," one known as a reference ship and the other a target ship. Based upon the problem group selected by the student, the program sets the initial value for the course, speed, range, and bearing of the two ships, and then issues contact reports based on their relative movement. The student is asked to supply the values for the following eight variables: direction of relative motion (DRM); measure of relative motion (MRM); speed of relative motion (SRM); bearing, range, and time of closest point of approach; and target course and speed.

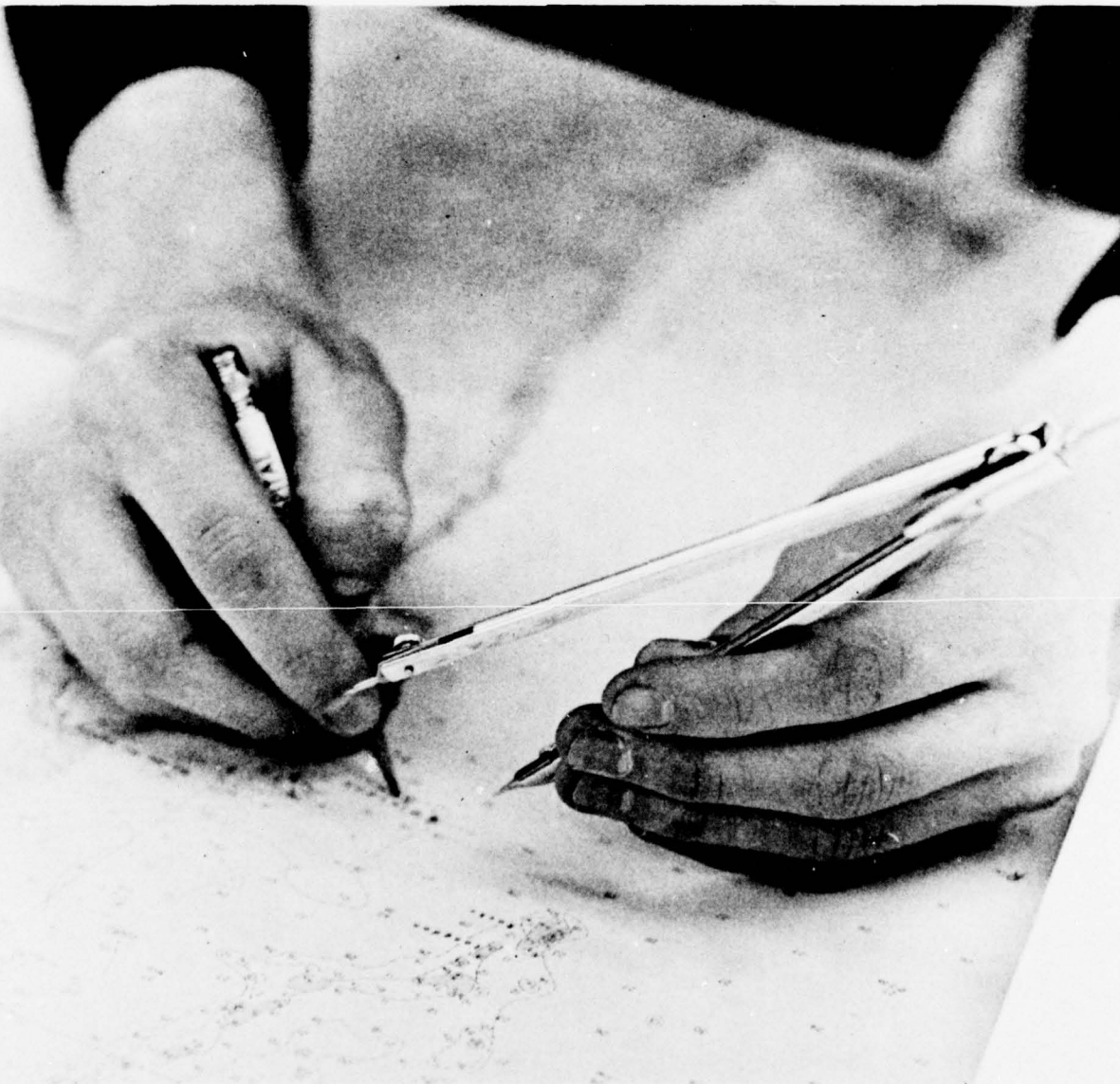


A CRITIQUE OF THE NATIONAL NAVIGATION PLAN

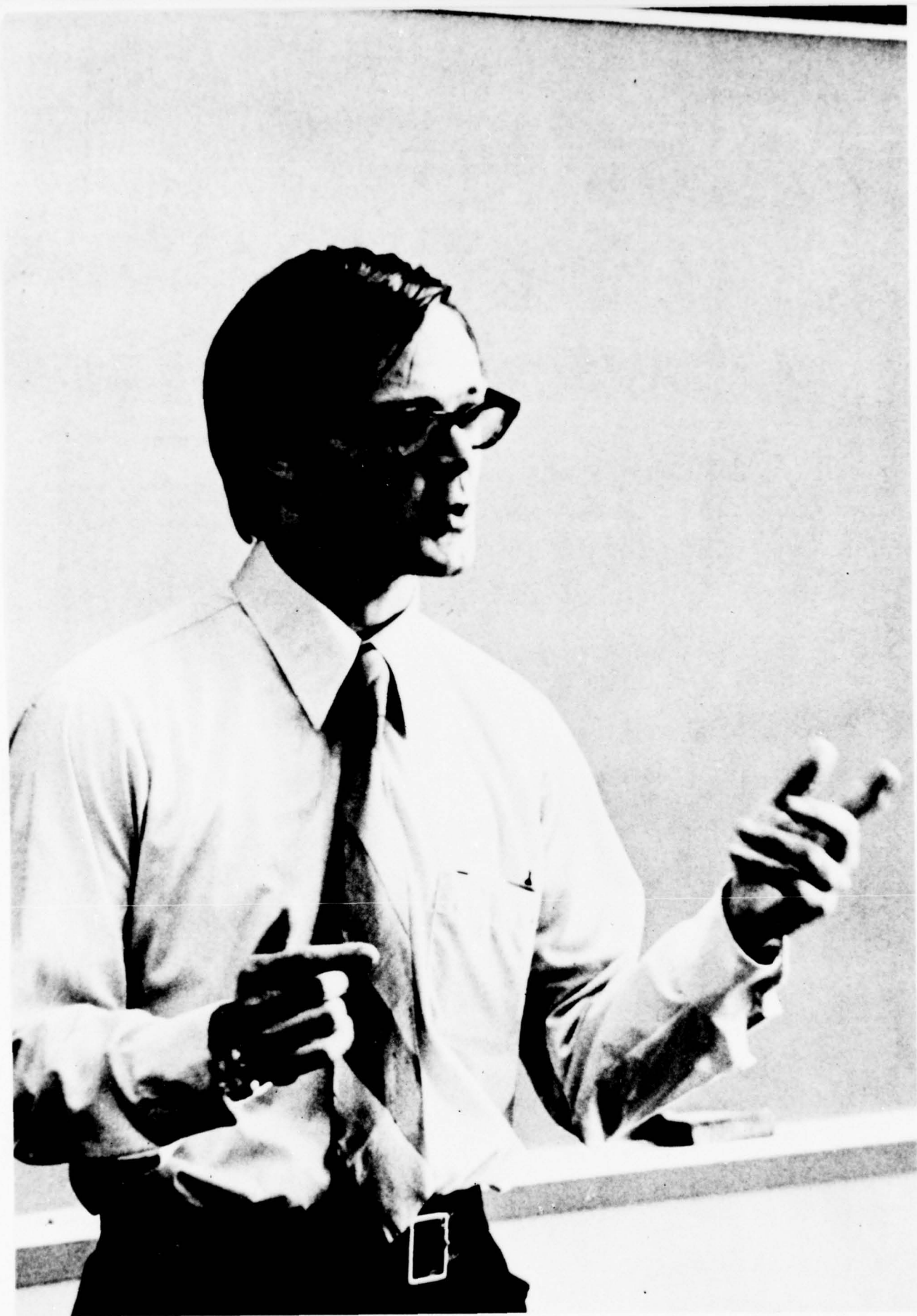
Researcher: Midshipman 1/C Stephen B. Latta

Adviser: Lieutenant James H. Blaisdell, USN

Congressional concern over the large expenditures for seemingly redundant navigation aids prompted the congressional tasking of Department of Transportation, and, within DOT, the U. S. Coast Guard, to review the present navigation systems and requirements and produce a National Navigation Plan. This project reviews the Department of Transportation's National Navigation Plan.



DIVISION OF  
U. S. AND INTERNATIONAL STUDIES



## ECONOMICS DEPARTMENT

*Associate Professor Clair E. Morris, Chairman*

Research in the Economics Department has continued at a commendable pace during this reporting period. The topics that have captured the interest of the faculty have been very much in the mainstream of research within the economics discipline, and cover such areas as national housing models, employment patterns in less-developed countries, returns to investment in education and training, economic effects of discrimination in job markets, and the analysis of public sector performance. The methodology used by the researchers has been increasingly quantitative with extensive emphasis on empirical tools of analysis. The work completed has been warmly received by respectable professional journals, in addition to getting good reception by organizers of professional programs.

The research effort of the Economics faculty adds an exciting dimension to the academic program of the Department. It contributes to a fertile interaction between this faculty and economists at other institutions throughout the country; it enlivens faculty seminars and corridor-exchanges as it imbues instructors with a higher level of professionalism; and it leads to an enhanced performance in the classroom by teachers who are confident of the currency of their knowledge.

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RESOURCE ALLOCATION IN NONPROFIT ORGANIZATIONS

Researcher: Assistant Professor F. Reed Johnson

Sponsor: Naval Academy Research Council

This study proposes to test several hypotheses regarding size, activity-composition, and benefit-distribution of nonprofit organizations. These results will be used to assess the effectiveness of public policies and expenditures influencing such organizations.

Using multiple-regression analysis and other econometric techniques the following four hypotheses will be tested:

1. The greater the fixed revenues of the nonprofit organization, the greater the level of activity.
2. Such increases in activity are not distributed uniformly over various functions of the organization; utility-detracting levels are reduced.
3. The more concentrated the nonprofit industry, the greater the use of discretionary nonprice rationing of output.
4. The greater the ease of entry, the smaller the size and the greater the costs of the organization.

The results will be interpreted for educational, health, religious, and cultural organizations, respectively. Data for testing has been acquired from the Internal Revenue Service, the National Center for Education Statistics, the University of Michigan Survey Research Center, the Corporation for Public Broadcasting, the United Methodist Church, the United Presbyterian Church, and the Mormon Church.

Regression equations have been estimated and tested for American public universities and private universities, hospitals, and churches. These preliminary results will be reported in a working paper.

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THE ECONOMIC IMPACT OF MILITARY SERVICE

Researchers: Associate Professors Roger D. Little and J. Eric Fredland

Sponsor: Naval Academy Research Council

This research concerns the value of military vocational training, and military service in general, to ex-servicemen in their civilian occupations. The basic approach is to compare those who have had military service and training with those who have not--for significant differences in civilian earnings. Multiple regression analysis is applied in comparisons to allow for the influence of other variables which affect earnings. The data used are from the National Longitudinal Survey.

This work resulted in: (1) presentation of results to Volunteer Training Unit 0601 (Research) of USNR, 2 August 1977; (2) a paper presented at the Atlantic Economic Conference, October 1977, entitled "Long Term Returns to Military Vocational Training"; (3) presentation of results of paper listed in (2) above, and results of paper entitled "Veteran's Status, Earnings, and Race" to the professional staff of Navy Personnel Research and Development Center, 4 April 1978; and (4) presentation of results in two Economics Department seminars.



## SURVEY AND CRITIQUE OF STUDIES OF FAILURES IN MULTIFAMILY SUBSIDIZED HOUSING

Researcher: Associate Professor J. Eric Fredland

Large numbers of multifamily housing projects subsidized under sections 236 and 221(d)(3) of the National Housing Act, as amended, are in default on their mortgages. In many cases projects have been foreclosed. There is considerable parallel between the multifamily housing problem and the more general problem of business failure.

The purpose of this study is to survey the studies of financial failure of multifamily housing projects and to investigate the similarities of such failure to that of business failure in general. Much of the existing literature consists of unpublished work sponsored by government agencies, and this material has been collected and reviewed. The survey also draws on the published literature of business failure as well as that on default/foreclosure experience in single family housing.

It is expected that this study will be completed by the end of the summer of 1978.

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## EMPLOYMENT AND SMALL TOWN INFRASTRUCTURE NEEDS

Researcher: Assistant Professor Arthur Gibb, Jr.

The intent of this study is to investigate the nature of the employment-generating potential in low and middle-income nations in the non-agricultural activity of their rural areas. Understanding of how such employment is related to agricultural growth is quite limited, but knowledge about structural transformation in rural areas is improving rapidly. Now, the problem is not so much lack of empirical evidence, but the fact that the evidence is fragmented and must be pulled together for in-depth analysis which this study attempts.

The conclusion from this work is that the agricultural sub-region with its two tiers of trade centers is the characteristic unit of the rural economy within which structural transformation occurs in all developing nations. Therefore, it is argued that a program for providing a social capital infrastructure and urban services directly to sub-regional trade centers is warranted if economic growth is to be enhanced. The benefits to be derived from such a program are: (1) the inequitable as well as inefficient island-pattern of rural structural transformation will be avoided; (2) more non-agricultural employment will be produced by a given increment of agricultural growth as a consequence of non-agricultural

production occurring at lower levels in the urban hierarchy where more labor-intensive techniques are used; and (3) there will be a lesser capital cost per job created, and, in addition, some of the capital required will be derived from savings which otherwise might not be mobilized for developmental purposes.

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WAGE EARNINGS RELATION OVER THE 1960-1974 PERIOD

Researcher: Assistant Professor Rae Jean B. Goodman

This is a continuation of a project which was begun with the support of the Naval Academy Research Council during the Academic Year 1976-1977. The purpose of this study is to establish the relation between the earnings and wages for men versus women and for white versus non-whites. Complex statistical tests have been developed to investigate the problem and considerable progress has been made. One of the conclusions is that women and non-whites are paid statistically significantly less than men and whites. This relation has changed little over the fourteen year period under study.

A second set of hypotheses are being tested concerning the occupational distribution of men and women and any changes that might have occurred in this area over the fourteen year period.

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SURVEY OF CONTEMPORARY MACROECONOMIC THEORY

Researcher: Associate Professor A. Royall Whitaker

This study took as its purpose a comprehensive review of the inconsistencies between macroeconomic textbooks and contemporary theory and models. The exhaustive survey of the literature which was made revealed numerous instances where serious misunderstanding of basic principles obviously exists.

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## THE PROPOSED NATIONAL LABOR REFORM ACT OF 1978: COMPARATIVE CHANGES TO EXISTING LAW, POTENTIAL EFFECTS ON EMPLOYERS, EMPLOYEES, AND UNIONS

Researcher: Midshipman 1/C William P. Ervin

Adviser: Associate Professor Roger D. Little

The guidelines specifying the basic structure within which unions and employers must conduct their business relationships with both prospective and current employees were outlined in the National Labor Relations (Wagner) Act of 1935. The Taft-Hartley Act of 1947 and the Landrum-Griffin Act of 1959 were major amendments to the Act. The National Labor Reform Act of 1978 was a bill that had already passed the House of Representatives, been endorsed by President Carter, and was at the time of this writing about to come before the Senate.

Though the bill passed the House easily, a probable battle loomed in the Senate. The bill was staunchly supported by big labor unions such as the AFL-CIO and vehemently opposed by big business lobbying groups such as the National Association of Manufacturers. Both sides spent enormous sums of money and their efforts concerning the legislation were typical of the great power and influence that big labor unions and business lobbying groups generate whenever important legislation comes before Congress. At stake in this case was the future credibility of big labor with the American worker, in terms of influencing Congress. The bill called for regulations that would enable unions to more easily enlist employees, to bring action more quickly in labor-management disputes, and impose stricter punishments on violators of the law. The bill came out at a time when union membership was on the decline and big labor had suffered embarrassment and loss of credibility because of recent failures to get labor-favoring legislation passed in Congress. A study of the circumstances surrounding the proposed legislation and a look at the probable effects of the bill on unions, employees, and employers was the main purpose of this project.

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FREDLAND, J. Eric, Associate Professor, co-author, Econometric Models of the Housing Sector: A Policy Oriented Survey. Washington, D. C.: The Urban Institute, June 1978.

Models of the housing sector and the housing equations of national economic models are examined in this publication. In addition, models developed primarily to analyze financial markets that also contain housing-starts or investment-equations are considered.

The body of the study is divided into five major sections: Section I describes basic housing-sector theory; Section II deals with housing data; Section III briefly discusses estimation methods employed; Section IV describes empirical results of policy analyses performed with the models; and Section V evaluates models surveyed in terms of their validity for policy analysis purposes. Throughout the study, the models are extensively cross-referenced, and an index is provided to aid readers interested in specific models. The publication's lengthy bibliography cites materials that directly discuss the housing models or housing sectors, materials that contain the housing equations of national models, data sources, and selected works that are often noted in, or discuss issues raised in, the model literature.

Although this study is especially intended to familiarize readers, particularly economists, who are not housing specialists with recent econometric models of national residential construction activity, experts in the housing field should also find it useful as a reference document.

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FREDLAND, J. Eric, Associate Professor, co-author, "On the Erosion of Public Facilities," Review of Social Economy, 36 (April 1978), 71-77.

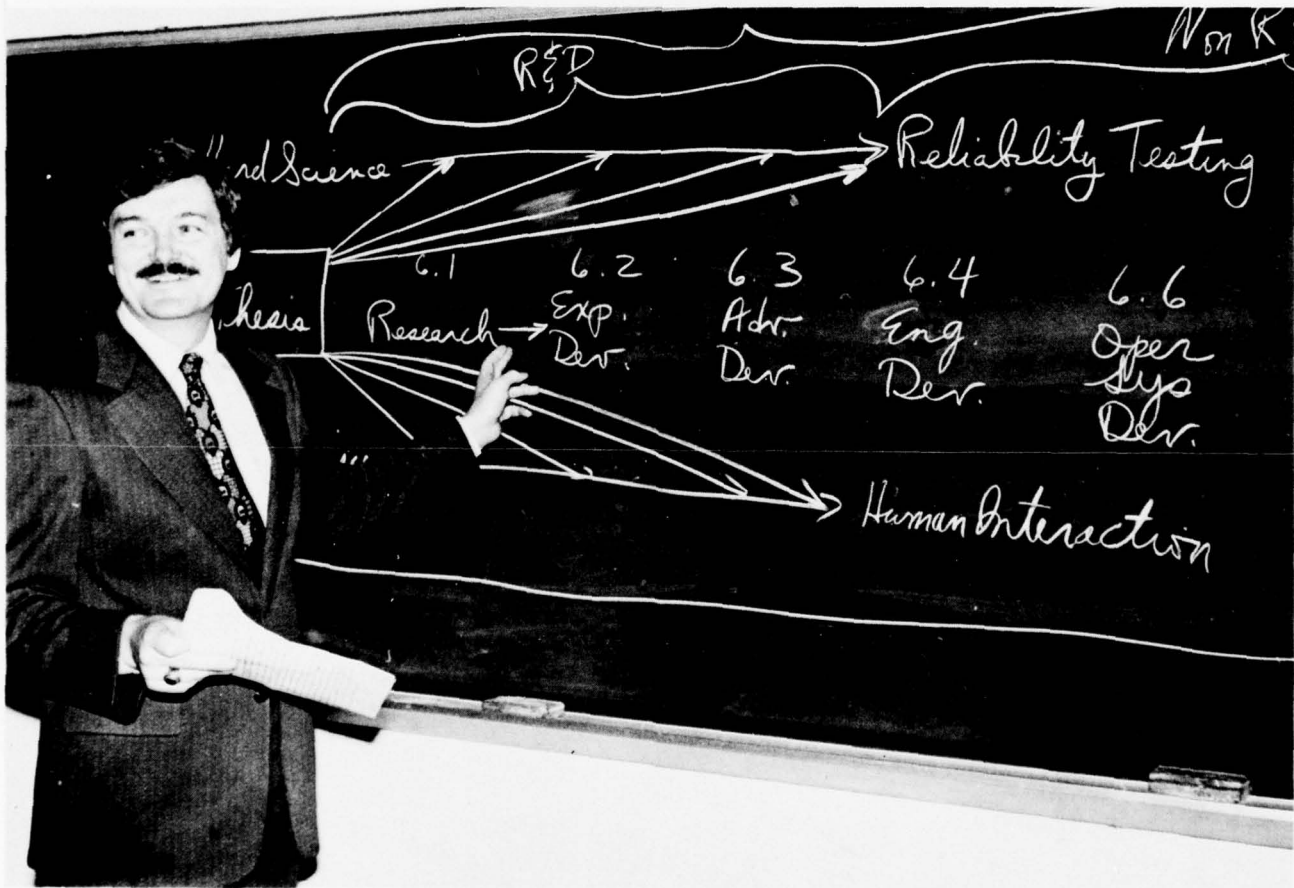
When the public sector provides facilities as a means of correcting a recognized "public bad," only the first step has been taken. Any facility, once established, is subject to various forms of erosions -- also "public bads." To explain why erosion is a particular public-sector problem, the authors present a taxonomy of erosion. They note that the nature of certain facilities, the nature of user groups, managerial incentives, and socio-political constraints on erosion-arresting behavior all contribute to making various types of erosion relatively worse in the public sector. Public facility erosion can be curbed to some extent, but differential erosion will inevitably remain because of high exclusion costs on certain public facilities.

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GOODMAN, Rae Jean B., Assistant Professor, "Computer-Augmented Video Education (CAVE) in Economics," Proceedings of the Ninth Annual Conference on Computers in Undergraduate Curricula, Denver, Colorado: University of Colorado Press, 1978.

This paper deals with the development and evaluation of the CAVE system at the Naval Academy. The CAVE system (Computer-Augmented Video Education) combines the computer and videotapes into an educational tool. The videotapes produced to date in Economics deal with macroeconomics-- Keynesian Analysis, The Income Expenditure Multiplier, Fiscal Policy, The Bank's Balance Sheet, Money Creation, and Monetary Policy. The computer programs associated with each videotape check the student's understanding of the concepts taught in each videotape. The programs are self-paced and the student is able to move throughout the videotape programs at will.

During the Academic Year 1977-1978, several tests were given to students who used the CAVE programs against those who had not. The students who had used the CAVE programs did significantly (statistically) better than those who did not use the programs.



PRESENTATIONS

ECONOMICS DEPARTMENT

FREDLAND, J. Eric, Associate Professor, and Roger D. LITTLE, Associate Professor, "Long Term Returns to Military Vocational Training," Economic Conference, Washington, D. C., October 1977.

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GIBB, Arthur, Jr., Assistant Professor, "Employment and Infrastructure Concomitants of Rural Growth," Meeting on Urban Infrastructure Development sponsored by the International Labour Office in Geneva, Switzerland, July 1977.

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GIBB, Arthur, Jr., Assistant Professor, "Spontaneous Rural Employment Generation," Eastern Economic Association Meeting, Washington, D. C., 28 April 1978.

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GOODMAN, Rae Jean B., Assistant Professor, "Computer-Augmented Video Education (CAVE) in Economics," Ninth Annual Conference on Computers in Undergraduate Curricula, Denver, Colorado, June 1978.

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## LANGUAGE STUDIES DEPARTMENT

*Professor Guy J. Riccio, Chairman*

Research activity in the Department remained at approximately the same level this year as last, with one new area of sponsored research, in which three faculty members were involved, representing the major addition to the pattern heretofore maintained. The sources of funding, insofar as sponsored research is concerned, were broader in 1977-1978 than in previous years and there was some evidence, judging by the contacts made with other agencies, that this outside support for certain research efforts will be maintained in the future. Overall, five faculty members were particularly active in one form of research or other and, of these, one was engaged in a project whose initial phase was funded by a Naval Academy Research Council grant. In the area of research-related activity at the student level, one midshipman undertook a two-semester independent project related to the Far East and using Chinese language sources.

The faculty, as a whole, continues to pursue informal investigation, or formal research efforts, sponsored or unsponsored, in a number of fields related to their particular language specialties. These include 16th century German literature, lexical studies in Spanish, contemporary Spanish American literature, current military doctrine in the Soviet Union, church-state relations in the Soviet Union, military leadership in the People's Republic of China, and, more recent areas of inquiry, Russian naval terminology and the exploits of certain 18th century French navigators in the waters of the New World.

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RUSSIAN-ENGLISH NAVAL DICTIONARY

Researchers: Assistant Professor Michael C. Halbig, project director;  
Professor Claude P. Lemieux, Lieutenant Irmeli S.  
Mäkelä, USN

Sponsor: Naval Intelligence Support Center

This project involves the editing, formatting, and proofreading of an existing English-Russian dictionary that has been reversed, manually, by personnel of the Naval Intelligence Support Center with all entries recorded on several thousand index cards. Software programs available through the Naval Academy Computing Center make the formatting and proofreading rather straightforward to accomplish, once all individual entries have been stored. Professor Lemieux and Lieutenant Mäkelä have been involved in editing the material prior to computer processing. Final, camera-ready, copy of the formatted dictionary, arranged alphabetically with all entries Russian-English, will be returned to NISC upon completion of the project, now expected in the fall of 1978. It is anticipated that the completed dictionary will then be published and ultimately disseminated within the American translation community.

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AN AUTOMATED BIOGRAPHICAL FILE ON CHINESE MILITARY LEADERSHIP

Researcher: Associate Professor Daniel T. Y. Lee

Sponsor: Defense Intelligence Agency

The purpose of this research, whose initial phase was sponsored by the Naval Academy Research Council, is to develop automated analytical biographies of the military leadership in the People's Republic of China. The concept of this work was based on the thesis that an adequate knowledge about China's military leaders is an essential point of departure for analysis of that country's politico-military development.

Following a three-week period of research undertaken in Taiwan and Hong Kong during the summer of 1977, the researcher was able to process, translate, and input a large number of biographical data from materials gathered on his visit. This effort has been followed by a process of periodically updating, revising, and reviewing the current file and, in addition, devising computer programs to establish leadership cross-linkage structures identifying possible factions and ascendancy patterns.

The Defense Intelligence Agency, evidencing its continued interest in this project, has approved a funding request for further development of the project in the upcoming fiscal year.

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A CRITICAL STUDY OF MAJOR DOCUMENTS IN CHINA'S POST-REVOLUTIONARY ERA

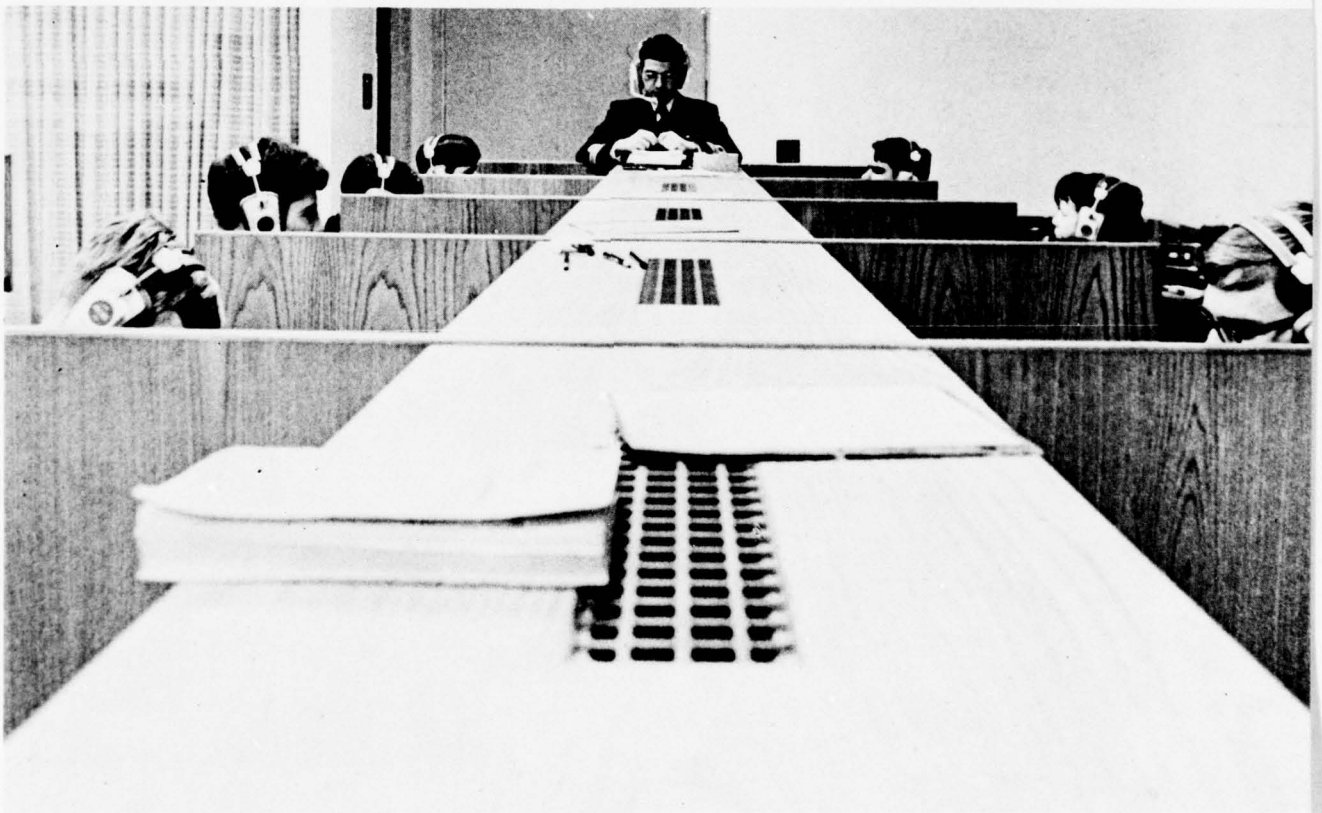
Researcher: Midshipman 1/C Murray S. Donovan

Adviser: Associate Professor Daniel T. Y. Lee

This research was undertaken by Midshipman Donovan to further his interest and capability in the study of documentary Chinese and thus broaden this facet of his work in his Far Eastern area-studies major.

The project, which was completed in May 1978, included an in-depth study of selected important documents, periodicals, and speeches by Mao Tse-tung during the period 1949-1957. All materials were in Chinese and were representative pieces of political literature on various topics: political, international, as well as ideological. In addition, selected writings from the Republic of China (Taiwan) sources dealing with more recent developments in the People's Republic of China were also included.

It was essentially a continuing effort to develop a command of the Chinese language adequate for firsthand understanding of Chinese materials as a basis for research in the field of contemporary Chinese studies. Oral reports in Chinese were a regular part of the course, followed by content discussions between the researcher and his adviser.



PRESENTATIONS

LANGUAGE STUDIES DEPARTMENT

HALBIG, Michael C., Assistant Professor, "The Helsinki Commission and Foreign Language Teaching." Keynote address at the Maryland Foreign Language Association Conference, Towson, Maryland, 8 April 1978.

\*\*\*\*\*

YARBRO, John D., Professor, "Formation des officiers de Marine des Etats-Unis." Paper read, in French, at the International Conference on Tradition and Change in Western Military Systems, Universities of Toulouse and Montpellier, Sorèze, France, 24-28 July 1977.



## POLITICAL SCIENCE DEPARTMENT

*Professor John R. Probert, Chairman*

The Political Science Department faculty of eleven civilians, five officers, and one Foreign Service Officer engaged in 29 research or research-related projects during 1977-1978. Three pieces of sponsored research were supported by the Department of the Navy's Energy and Natural Resources Office and Electronics Systems Command and the Office of the Assistant Secretary of Defense for International Security Affairs. Two independent research topics were "Congress as a Career" and "Naval Academy Recruitment." Eleven midshipmen undertook research, with faculty guidance, in research course projects, three of them in preparation for participation in round tables of the Naval Academy Foreign Affairs Conference.

Of the five publications by faculty, one, a research monograph published by the American Political Science Association, was an intern's guide to National Government. Another dealt with Congressional use of computers, and a third was published in Mexico City in the Annals of the 30th International Congress of Human Sciences in Asia and North Africa.

Eight papers were read by faculty members at meetings of professional societies, ranging from the Washington Center for Learning Alternatives to the Institute for World Affairs in San Diego to the Southwestern Political Science Association in Houston.

Methodological variation also characterized the Political Science Department's research effort, including descriptive, historical, and normative approaches, as well as the behavioral approach, with its emphasis on the empirical with extensive quantification. The Department's unparalleled computerized data resources have been most conducive to the latter approach and represent a continuing inducement to research along those lines.

The Political Science Department's extensive and varied involvement in research and publication serves principally to enrich, update, and vitalize the instruction of midshipmen both in and out of classroom. It also, however, materially enhances the academic reputation of the Naval Academy while it serves, in some instances, to advance the course of national defense.

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U. S. NAVY AND CRISIS-OF-ENERGY AWARENESS

Researcher: Professor Rocco M. Paone

Sponsor: Naval Academy Energy/Environment Study Group  
(Navy Energy and Natural Resources R&D Office)

This study is divided into five major sections: Importance of Energy Awareness in Political Science Curricula; Importance of Energy Awareness in Economics Curricula; Requirements of National Energy Goals and Policy; Energy Direction of the Department of Defense; and the Navy's Response to the Energy Crisis.

Emphasis is placed on the hypothesis that the energy situation of today comprises a complex set of important and interrelated problems, political, economic, technological, and social, domestic, and international, with each having possible solutions, portions of which are unsatisfactory to certain groups of people, individuals, and nations. There is little doubt that a worldwide energy crisis can paralyze United States industries and those of other developed nations, including our allies, and thus threaten the security of the United States and the West. Such a potential development also poses to the United States in particular "the greatest combination of technical, economic, and social challenges in history."

With so much of our national security involved in energy problems and with such vital challenges facing the country, the study then proceeds to explain the reaction of the Department of Defense and that of the Navy to the potential danger. In an effort to make midshipmen more cognizant of the need for a fuller comprehension of energy awareness, suggestions are made for enriching courses in Political Science and Economics by including a number of energy-related topics. Opportunities for introducing these ideas are also designated. Training aids such as charts on U. S. and World Energy Sources, Crude Oil Reserves, Coal Reserves, Worldwide Patterns of Oil Production (including the sea routes), Energy Supply Lead Times, among others, are included in the body of the study and the Appendices.

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UNITED STATES SECURITY POLICY AND THE SRV: THE ASEAN VARIABLE

Researcher: Associate Professor Robert L. Rau

Sponsor: Office of the Assistant Secretary of Defense/International Security Affairs, East Asia and Pacific Branch

This study discusses the current state of relations of the United States and the Socialist Republic of Vietnam. Specifically, it covers the Missing-in-Action question, joint economic matters, security, and defense. The study also outlines capabilities and the intent of the Socialist Republic of Vietnam in Southeast Asia.

The "ASEAN Variable" factors in the Association of South East Asian Nations countries of Malaysia, Indonesia, Philippines, Singapore, and Thailand as other interested parties in contemporary Southeast Asia.

The final section of the paper suggests recommendations for future behavior of the United States. The study is classified Confidential and is completed.

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COMMAND AND CONTROL SYSTEMS TEST AND EVALUATION GUIDE

Researcher: Assistant Professor Rodney G. Tomlinson

Sponsor: Naval Electronics Systems Command (PME 108)

The purpose of this project was to compose a manual for naval officers assigned to duties as directors of test and evaluation in the project offices of the Naval Electronics Systems Commands. Important DOD directives are identified and summarized into a single comprehensive set of guidelines so that Command and Control systems tests and evaluations can be properly planned, funded, and completed to ensure maximum quality at minimum expense. In addition, insights, advice, and suggestions are presented, based upon the author's interviews with a number of experienced military officers in the Army and Air Force. The manual has been completed.



DEMOCRATIZATION OF RECRUITMENT AT THE U. S. NAVAL ACADEMY

Researcher: Associate Professor John A. Fitzgerald

This project involves an examination of demographic characteristics of USNA graduates from 1930 until the present. The primary theoretical thrust of the research is a test of Janowitz's hypothesis that military officer recruitment underwent "democratization" following World War II. Utilized as the principal source of data are the results of ACE surveys made of members of successive entering classes of USNA. The project is still in progress.

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CONGRESS AS A CAREER

Researcher: Assistant Professor Stephen E. Frantzich

This ongoing research project attempts to discover the causes and consequences of "careerism" in the U. S. Congress. Despite the intentions of the Founding Fathers that Congress should be made up of amateur politicians who are close to the people, the current Congress is made up predominantly of individuals who see it as a long-term commitment. This situation affects the way in which congressmen perform their jobs. Through the analysis of career and behavioral data, the type and degree of impact are being analyzed.



## THE EXCLUSIONARY RULE -- WHY THIS?

Researcher: Midshipman 1/C James T. Byers

Adviser: Lieutenant J. Gregory Wallace, JAGC, USNR

In fulfillment of the requirements of the course FP496, Topics in Political Science, Midshipman Byers elected to investigate the history behind and the alternatives to the judicial ruling excluding evidence from trial in cases where the evidence was gathered contrary to the provisions of the Fourth Amendment to the U. S. Constitution.

Byers' premise was that the Exclusionary Rule served inadequately to protect the rights of privacy and security guaranteed by the Fourth Amendment inasmuch as no substantial improvements in police techniques have been noted. The exclusionary rule places no liability on the investigating officers should they violate the Amendment's provisions; instead, it results in the release of otherwise guilty persons and hampers society's efforts to combat crime.

Through research in alternative methods of enforcing similar protections in other nations, Byers concluded that a system imposing civil liability upon the police officers and investigators would better protect the particular rights offered by the Fourth Amendment. However, his conclusion favors retention of the exclusionary rule in a greatly limited application to cover the contingencies where such civil liability might not be truly effective.

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NORMALIZATION OF SINO-JAPANESE RELATIONS AND THE PROSPECTS OF DETENTE  
IN THE PACIFIC

Researcher: Midshipman 1/C Alexander Callas

Adviser: Assistant Professor Rodney G. Tomlinson

The evolution of Sino-Japanese relations was examined, leading to the observation that normalization of relations largely hinges on factors that make it useful for China to seek Japanese friendship. Most notable are the issues of Taiwan and the Soviet threat to China. Japan has accommodated China on the former, and the continued Soviet military threat has impelled China into developing cordial relations with Japan once the U. S. broke the ice with the Kissinger/Nixon overtures. Further improvement in relations between Japan and China hinge now on Japanese intentions -- and actions. So long as the Japanese maintain a modest military establishment and continue their expansion of trade with China,

the hope for a genuine detente in the Western Pacific remains good. Within this environment the Soviets might be persuaded to minimize their adventurism towards China, leading them to eventually join the group for a sort of "triangular detente."

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A HISTORICAL PERSPECTIVE OF U. S.-CHINESE RELATIONS AND ITS IMPLICATIONS FOR AMERICA'S CHINA POLICY

Researcher: Midshipman 1/C James A. Fiorelli

Adviser: Associate Professor Robert L. Rau

As Chinese participation in the realm of international affairs grows, so too America's policy toward China and resulting Sino-American relations becomes increasingly important. The ability to comprehend and conceptualize America's present China policy and the direction that policy should or could take in the future, hinges largely on an understanding of past Sino-American relations.

This paper is divided into two parts. The first part traces the history of Sino-American relations since the birth of the United States. It concentrates mainly on U. S.-Chinese relations in the last forty years, highlighting the basic trends which have existed in these relations, and identifying the most obvious and damaging errors which have been made in foreign policy formulations. These errors were the result of a number of misperceptions, including the inability to realize the absence of a strong alliance between the Communist movements in China and the Soviet Union.

The second part of this paper is concerned mainly with recent Sino-American relations and the apparent trend toward accommodation and possible normalization. The major emphasis is on the factors which caused the formulation of the Shanghai Communique, the subsequent relationship between the two countries, and the implication all of this has on the future foreign policy patterns of both the U. S. and China.

Finally, the conclusion summarizes the major points of knowledge and understanding which have been grasped in this extensive study of Sino-American relations.

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## THE CENTRAL INTELLIGENCE AGENCY: BACKGROUND FOR REORGANIZATION

Researcher: Midshipman 1/C C. Jeffrey Grogan

Adviser: Foreign Service Officer-4 Gordon Shouse

This project was undertaken by Midshipman Grogan in preparation for his participation in the Naval Academy Foreign Affairs Conference and for credit as independent study. He examined in depth the recent developments related to the reorganization of the U. S. intelligence community. His research surveyed general works, periodicals, and unclassified government publications and was supplemented by interviews with several officials in the intelligence community.

Midshipman Grogan reviewed the conception and evolution of the CIA, discussed the covert activities which led to demands for reform, and analyzed the reorganization plan which is now being implemented. He found that the Executive Order which specifies the new structure of the CIA places renewed emphasis on intelligence gathering at the expense of covert activity. While covert operations are subject to close scrutiny, they will be permitted only with the specific approval of the President. Thus the reorganization does not meet the demands of CIA's more strident critics, but it does give wide powers to the Director of CIA.

It was concluded that the reorganization will avoid steps which might weaken our intelligence capabilities, while it does impose needed controls over activities which pose a threat to our democratic tradition and have caused damage to the conduct of our foreign policy.

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## AN ANALYSIS OF U. S. STRATEGIC DOCTRINE

Researcher: Midshipman 1/C Don P. Hamblen

Adviser: Assistant Professor Stephen E. Frantzich

A review of the history of the development of strategic arms policy reveals that policy-formulation follows the technological developments in strategic arms. This is due to the technological requirements necessary for the employment of a particular strategic doctrine. It is safe to assume that this trend will continue until such time as agreements concerning strategic weapons-technology can be reached.

The slow progress in the SALT negotiations can be traced to basic political factors. Each side perceives a threat from the other and as a consequence is unwilling to gamble with its national security and national interest in altruistic hopes of making the world safer by limiting strategic weapons. Until such time as the mutual perception of a threat is reduced, fruitful negotiations are doubtful. This reduction of perceived threat is a function of the amount of international interchange between the two nations. As economic and social interdependence grows, the likelihood of armed aggression is reduced. When the values of a stable international system are internalized to a high degree, then tacit arm limitations will occur.

As was stated early in the study, the qualitative arms race will pose problems for the SALT negotiations. One of the principal problems will be how to limit technology effectively. While the limitation of research concerning nuclear materials is feasible, the limitation of associated technology which has a use in conventional weaponry or in other non-military uses would be quite difficult to effect. The resolution of this problem, in light of this research, does not seem to lie in the foreseeable future.

As a consequence, the development of a new strategic weapons-technology will continue in large part to shape the strategic policies of both nations.

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#### THE OCEAN SEABED: PROBLEMS AND POSSIBILITIES

Researcher: Midshipman 1/C Christopher H. Jensen

Adviser: Foreign Service Officer-4 Gordon Shouse

This study, which was written in preparation for the Naval Academy Foreign Affairs Conference and as a Political Science course project, examines the technical, economic, and political issues involved in the exploitation of mineral resources in the ocean seabed. The research focused on the availability of resources, the economic feasibility of mining, and the problems involved in establishing international regulatory controls.

Midshipmen Jensen concluded that the mining of the seabed will offer significant economic promise for the not-too-distant future. The technology now exists to exploit mineral resources, particularly those contained in manganese nodules, and several international consortia plan to begin mining within a few years. This technological progress has lent urgency to the need for international control of mining activities.

The political considerations of regulation have caused a polarization of attitudes which can be roughly divided into those countries which lack capital and technology to begin mining, countries which now export minerals and fear competition from the seabed nodules, and developed countries who wish to begin mining in the near future. The prospects for early agreement in the Law of the Sea negotiations are not promising. If a compromise cannot be reached soon, there is a strong possibility that mining may begin without a formal agreement. This situation may provide impetus for the less-developed nations to become more flexible in order to protect their national interests.

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#### A BIBLIOGRAPHIC ESSAY ON LATIN AMERICAN DEVELOPMENT POLITICS

Researcher: Midshipman I/C Horace M. Leavitt

Adviser: Professor George Pope Atkins

The investigator pursued an independent reading course on the general topic of Latin American development politics. His purposes were primarily, to become more familiar with the literature of development theory as it relates to Latin America in a broad cultural context; and, secondarily, to increase his proficiency in the Spanish language, especially in the vocabulary of politics. He read a set of books, some in Spanish, chosen with the adviser's approval; consulted periodically with the adviser; and submitted a comparative bibliographic essay and defended it orally with the instructor. He searched for theoretical commonalities and differences among the various authors read. Specific themes included elements of development theory, the impact of Latin American society and culture on political development, and the relative political roles of the armed forces, landowners, bureaucracy, businessmen, the Church, political parties, and students. He evaluated the theoretical and empirical validity of each author's treatment and drew his own conclusions about the various themes analyzed.

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#### GROWTH AND EXPANSION OF THE SOVIET NAVY -- 1952 TO 1977

Researcher: Midshipman I/C Charles Love

Adviser: Assistant Professor Rodney G. Tomlinson

This project undertook to validate an existing computer data file of the Soviet Navy (1952-1972) and to update the file for the years 1973-1977. An analysis of the revised data underlines the phenomenal growth of the Soviet Navy as it evolved from a coastal force oriented to mine warfare to a blue-water fleet. In 1953 the Soviet Navy boasted only 23

warships of tonnage greater than 4,500 tons; in 1977 it had 135. The shift from mine warfare appears when one notes the drop in mining capacity from a peak of 900 mines in 1962 to 308 mines today. The thesis that the Cuban missile crisis represents a significant watershed in Soviet naval growth appears questionable when one graphs the growth curves for the numbers of modern warships. The existence of the Sverdlov-class light cruiser and appearance of early models of the Kresta-class suggest that the Soviets had a capable surface force at the time. Perhaps Premier Khrushchev viewed the confrontation of surface forces an unnecessary risk.

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#### OIL SPILLS: AN INTERNATIONAL PROBLEM

Researcher: Midshipman 1/C Gary W. Lovgren

Adviser: Assistant Professor Stephen E. Frantzich

The primary objective of this research project was to examine the past effects of oil spills and to investigate any national or international laws that have been enacted to prevent further spills. Proposed legislation was also touched upon. The effectiveness of such proposed laws was reviewed.

With the increased amount of oil-transport on the seas, the probability of spills has become a problem of increasing concern. Action must be taken to insure safeguards in new tankers. The question of liability and responsibility for accidents must also be solved. The price of cleanup should not be borne by those who suffer the effects of the spills. Overall, the most sensible approach is to enforce preventive measures; only in this way can the cost and consequences of any spill be prevented.

The problem of oil spills is an international problem. Problems of enforcement result. Who has the jurisdiction and the power to force another nation to adhere to a specific set of regulations? What sanctions can be imposed? Most recommendations are set by international conventions, conventions which must be ratified by the different nations before they are enacted. This is a slow process and a largely inefficient one.

The problem finally condenses to one of economics. When enforceable regulations are set, stating who is liable, and when oil becomes too valuable to be lost to the high seas, then action will be taken to prevent future spills. Until that time, those nations who suffer from pollution resulting from oil spills will continue to cry for help, and the oil transporting nations will meet these cries with a partially-deaf ear.

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## AN ANALYSIS OF SOVIET-CUBAN INVOLVEMENT IN AFRICA

Researcher: Midshipman 1/C Kurt W. Tidd

Adviser: Foreign Service Officer-4 Gordon Shouse

This study examines the motivation and objectives of the dramatic increase in Soviet and Cuban involvement in the African continent, and evaluates the options open to the United States in dealing with the situation in Africa. The project analyzes periodicals and the extensive news coverage of events taking place in Africa, and considers economic data related to Soviet aid to Africa.

The study traces the history of Soviet and Cuban involvement in Africa and discusses the relationship of nationalism to the successes and failures of Soviet diplomacy. The rapid increase in the Cuban presence in Africa is considered in the context of Cuban dependency on Soviet aid, desire for prestige in the Third World, and ideological goals. The study concludes that Soviet and Cuban interests coincide to form the basis for an effective alliance which poses a growing threat to Africa.

The researcher considered a number of possible actions to counter the growing Soviet and Cuban presence in Africa. Among these possibilities are joint action with Western European nations, military aid to guerrilla movements in Angola and Eritrea, and linkage of Soviet activities in Africa to the Strategic Arms Limitation Talks.

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## TECHNOLOGY AND THE LAW

Researcher: Midshipman 1/C Brice E. Zimmerman

Adviser: Lieutenant J. Gregory Wallace, JAGC, USNR

In fulfillment of the requirements of the course FP496, Topics in Political Science, Midshipman Zimmerman elected to investigate the typical research and drafting procedures found in the legal profession and to determine whether and how current generation computer technology might be employed to make such operations more efficient.

The researcher investigated the three primary computerized research systems, LEXIS, WESTLAW, and LITE, analyzing their respective strengths and weaknesses. He then researched various types of word-processing systems, as well as an innovative computerized evidence-and-document storage and retrieval system. With this background, he prepared a survey

directed to randomly selected law firms across the country, soliciting information regarding current computer usage, word-processing applications, the opinions and attitudes of practitioners regarding their acceptance of technological advances in the field, and a brief description of the size, nature, and automation of their practice.

The researcher's findings are critical of the current state of the art in the legal-research capabilities of the computer-research systems. He shows the direct relationship of lack of sophistication in the systems to the lack of use by the legal profession. The cost must be reduced before the profession will undertake more widespread advantage of computer capabilities. However, the attitudes expressed in the survey indicate a willingness to investigate technological systems once these areas are improved. Word-processing systems are generally in use at the present time, with an increasing awareness of the potential for efficiency and flexibility which they offer.

The study concludes that technology, while still in its infancy in the legal profession, is making great strides toward revolutionizing the typical practice of law in America, with resultant benefits not only to legal practitioners, but to society as a whole.



ATKINS, G. Pope, Professor, "Mutual Security in the Changing Inter-American System: An Appraisal of OAS Charter and Rio Treaty Provisions," Military Issues Memorandum, Strategic Studies Institute, U. S. Army War College, Carlisle Barracks, Pennsylvania, 25 July 1977, ACN 77029, 23 pp.

This paper is concerned with inter-American security principles and practices, as provided for in the Inter-American Treaty of Reciprocal Assistance (Rio Treaty) and the Charter of the Organization of American States (OAS Charter), in the environment of a changing Inter-American System. In 1975 a Conference of Plenipotentiaries approved a Protocol of Amendment to the 1947 Rio Treaty that, if adopted, will alter the basis for inter-American security collaboration. Only five years earlier, the members of the OAS had put into effect a set of amendments to the 1948 Charter; further amendments are under consideration, with considerable relevance to security cooperation.

The process of continuing Rio Treaty and OAS Charter amendment reflects shifting views of regional security interests in an atmosphere of divisiveness and uncertainty about the future of the Inter-American System. The present analysis of the constitutional bases for hemispheric security is placed in the larger context of regional organization politics, relating security concepts to general problems and trends that have stimulated OAS Charter and Rio Treaty reform and have been reflected in the revised documents.

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FRANTZICH, Stephen E., Assistant Professor, Storming Washington: An Intern's Guide to National Government. Washington, D. C.: American Political Science Association, 1977.

This research monograph outlines ways in which political interns can make the most out of their opportunity to observe politics up close. In order for them to start out on the right foot, interns are given hints on how to select the optimal internship setting. Once in the internship, they are appraised of the potential opportunities and pitfalls. Based on the premise that internships can complement academic learning, suggestions are made as to research strategies most applicable to internships.

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FRANTZICH, Stephen E., Assistant Professor, "Congress by Computer," Social Policy, 8 (January/February 1978), 42-45.

Recognizing the dramatic expansion of computerized administrative and analysis applications available to individual members of Congress, the author describes a day in the life of a hypothetical member who has taken advantage of every available application. After describing

the uses computers can be put to in the political realm, the article discusses some of the political implications of having national legislators using sophisticated computer applications for political and analysis purposes.

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FRANTZICH, Stephen E., Assistant Professor, "De-Recruitment: The Other Side of the Congressional Career Equation," The Western Political Quarterly, 31 (March 1978), 105-126.

Focusing on the neglected de-recruitment end of congressional careers, this article shows that the factors associated with leaving office are both intrinsically important and also necessary for opening the door to recruitment of a new member. Using behavioral manifestations of Joseph Schlesinger's ambition patterns as both dependent and independent variables, this analysis shows that members leaving Congress are differentiated both by the sources and consequences of their departure. The concepts of vulnerability, disability, opportunity and job desirability emerge as the factors which help explain whether a member will leave voluntarily through progressive or discrete ambition or be forced out while still harboring static ambition. The variable consequences of de-recruitment patterns emerge by analyzing pre-departure changes in behavior and the behavioral consequences of different predecessor/successor patterns.

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RAU, Robert L., Associate Professor, "A Survey of Singapore's Relations with Indonesia and Malaysia, 1965-1975." Annals of 30th International Congress of Human Sciences in Asia and North Africa, Mexico City, January 1978, 199-235.

This paper discusses the role of Singapore in its regional relations with Indonesia and Malaysia. Emphasis is placed upon political, diplomatic, and security issues.

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FRANTZICH, Stephen E., Assistant Professor, "Improving the Knowledge of Congress Through Computerized Information Technology," Annual Meeting of the Southwestern Political Science Association, Houston, Texas, April 1978.

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FRANTZICH, Stephen E., Assistant Professor, "Making Internships Academic Experiences," Annual Meeting of the Midwest Political Science Association, Chicago, Illinois, April 1978.

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FRANTZICH, Stephen E., Assistant Professor, "Making the Internship A Learning Experience," 1977 Meeting of the Washington Center for Learning Alternatives, Washington, D. C., September 1977.

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FRANTZICH, Stephen E., Assistant Professor, "Who Makes Our Laws: The Legislative Effectiveness of Individual Congressmen," Annual Meeting of the Northeast Political Science Association, Mt. Pocono, Pennsylvania, November 1977.

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TOMLINSON, Rodney G., Assistant Professor, "Forging the Right Tool for the Right Job: Uses of Computers in the Development and Exploration of International Relations," Panel on the "Semantics of International Relations Data," Annual Meeting of the International Studies Association, Washington, D. C., 22-25 February 1978.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER <b>14</b> USNA-AR-4	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER <i>rept</i>
4. TITLE (and Subtitle) <b>6</b> Summary of Research Activities Academic Departments 1977-1978	5. TYPE OF REPORT & PERIOD COVERED <b>9</b> Annual, 1 July 1977 - 30 June 1978	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Compiled and Edited by Professor <u>Wilson L. Heflin</u>	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Office of the Academic Dean U. S. Naval Academy Annapolis, Maryland 21402	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS N/A <b>12</b> 282p	
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE <b>11</b> Sept 1978	13. NUMBER OF PAGES 275
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This annual report summarizes the research work of the Naval Academy faculty and midshipmen for the period 1 July 1977 - 30 June 1978. Sponsored and independent research projects are listed by title, followed by the names of the investigators and an abstract. A list of publications and their abstracts are included as well as presentations at professional meetings, conferences, and seminars.		

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